Tailrace Egress of Yearling and Subyearling Chinook Salmon and Juvenile Steelhead Following Juvenile Bypass System Passage at John Day Dam, 2002.

Annual Report of Research for 2002

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EXECUTIVE SUMMARY

In 2002, the U. S. Geological Survey (USGS) used radio telemetry to examine the movements and behavior of yearling and subyearling Chinook salmon (*Oncorhynchus tshawytscha*) and yearling steelhead (*O. mykiss*) in the tailrace of John Day Dam (JDA). Study objectives were to describe the behavior of radio-tagged fish released through the juvenile bypass system (JBS) under different spill regimes to determine egress time and travel routes.

Test Conditions

The proposed spill conditions were either 0% during the day and 60% at night (12 – h spill) or 30% during the day and 30% at night (24 – h spill), assigned in a randomized block design. This design consisted of 4-day blocks that contained 2 days of each condition. Comparisons were made between the proposed 30% night and 60% night spill conditions. The actual mean spill during releases of yearling Chinook salmon and steelhead was 30% during planned 30% spill, and 57% during 60% planned spill. The actual mean spill during subyearling Chinook salmon releases was 33% during proposed 30% spill and 52% during proposed 60% spill.

Number of Fish Released

During the spring outmigration at JDA we released 93 radio-tagged hatchery-reared yearling Chinook salmon and 88 radio-tagged wild juvenile steelhead. We released 65 radio-tagged hatchery-reared subyearling Chinook salmon during the summer outmigration. All releases occurred between approximately 1900 hours and 0200 hours.

Travel Times

Comparisons of travel times from the JBS outfall to each of the three exit sites indicated that low spill resulted in more rapid tailrace egress than did high spill. This trend, however, was not always statistically significant. Fish were able to exit the immediate tailrace (Exit 1) within 11.7 min during low spill and 25.1 min during high spill.

The median travel time of yearling Chinook salmon from release to Exit 1 was significantly greater during 57% spill than during 30% spill. Results for juvenile steelhead were similar, with significantly greater travel times from release to Exit 1 during 57% spill. During the summer, travel times for subyearling Chinook salmon were similar to those observed in the spring. The median travel time of subyearling Chinook salmon from release to Exit 1 was significantly greater during 52% spill than during 33% spill.

Travel Rates

Analysis of travel rates showed the greatest amount of delay in tailrace egress occurred within the area between the JBS outfall and Exit 1 during periods of high spill. During the spring, both yearling Chinook salmon and juvenile steelhead released through the JBS had a median travel rate to Exit 1 that was twice as fast during 30% spill than was observed during 57% spill. During the summer, travel rates of subyearling Chinook salmon to Exit 1 were similar to those of yearling Chinook salmon.

Travel Routes

Boat tracking was used to monitor individual fish movements within and downriver of the Boat Restricted Zone (BRZ). During the spring, travel routes were determined for 40

yearling Chinook salmon and 26 juvenile steelhead during 30% spill, and 26 yearling Chinook salmon and 31 juvenile steelhead during 57% spill. During the summer, travel routes were determined for 33 subyearling Chinook salmon during both 33% and 52% spill. These locations were plotted to determine routes of travel for individual fish. Typical routes follow the southern shoreline through the BRZ, and continued along the south edge of the dredge island.

Atypical Travel Routes

A fixed-site receiving station was established upriver of the JBS outfall to monitor fish movements and residence times. During the spring, no fish were detected within this area during 30% spill. However, 12% of the radio-tagged yearling Chinook salmon and 26% of the juvenile steelhead were detected during 57% spill. During the summer, 4% of subyearling Chinook salmon were detected within this area during 33% spill, and 10% were detected during 52% spill. The residence time within this area influenced the total travel time in the tailrace. Yearling Chinook salmon that were detected at this site had a 5% delay, and juvenile steelhead had an 11% delay. The subyearling Chinook salmon that were detected at this site had a 52% delay during 33% spill, and a 30% delay during 52% spill.

Some fish traveled on a northern heading and entered the spillway outflow after exiting the JBS outfall. Fish that entered the stilling basin had longer travel times than fish that moved directly downriver following release. During the spring, the median travel times of both yearling Chinook salmon and juvenile steelhead that entered the stilling basin were greater than that of fish that moved directly downriver, regardless of spill condition. During the summer, subyearling Chinook salmon that entered the stilling basin had longer travel times than those that moved directly downriver following release, but were represented by a small sample size.

Dredge Island Passage

The route of passage (north or south) around the dredge island was not influenced by spill condition. During both spring and summer, fish passed to the south of the dredge island with few exceptions.

Volitionally-Passed JBS Fish

Residence time from the JBS outfall to Exit 3 was determined for fish volitionally passing JDA via the JBS. During the spring, the median travel times to Exit 3 for both yearling Chinook salmon and juvenile steelhead were significantly longer for fish passing the dam during planned 60% spill than during planned 30% spill. During the summer, subyearling Chinook salmon median travel times to Exit 3 were not significantly different during planned 30% and 60% spill releases.

Volitionally-Passed Spillway Fish

Residence time from spillway passage to Exit 3 was determined for fish volitionally passing JDA during planned 30% day, 30% night, and 60% night spill conditions. These fish were also monitored for delay and predation at an eddy site located at the north end of the spillway along the exterior navigation lock wall. Median travel times for yearling Chinook salmon passing the north half of the spillway to Exit 3 were significantly different during planned 30% day, 30% night, and 60% night spill releases. Median travel times for juvenile steelhead and subyearling Chinook salmon were not significantly different for fish passing either the north or south half of the spillway to Exit 3 during the three spill regimes. Fish volitionally passing through the spillway had faster median travel times to Exit 3 than fish released directly

into the JBS. Low incidences of fish were detected within the eddy during the three spill regimes. But, predation occurred to 21% of those fish detected within the eddy. This indicates that the few fish that are entrained within this area may be at greater risk for predation.

INTRODUCTION

A Supplemental Biological Opinion issued by the National Marine Fisheries Service (NMFS) recommended that spill at dams on the Columbia and Snake rivers should be maximized without exceeding the current total dissolved gas cap levels or other project-specific limitations (NMFS 2000) in order to increase juvenile salmonid (*Oncorhynchus spp.*) survival. Juvenile salmonids migrating downriver can be diverted from turbine passage routes at the John Day Dam (JDA) by turbine intake bypass systems (such as submerged screens) or by passage over the spillway.

Although spill is an effective route of passage, it can produce hydraulic conditions within the tailrace that increase fish vulnerability to predation, directly or indirectly, by extending the amount of time they spend in the immediate tailrace. Tailrace conditions are an important factor to consider in moving juvenile salmonids past hydroelectric facilities. Some operational conditions may create areas of decreased water velocity that may cause extended egress time, potentially exposing fish to elevated levels of dissolved gas. Other conditions may direct flow into areas where predators congregate. By monitoring and describing fish movements in the tailrace, we can compare fish behavior under different operational conditions (Liedtke et al. 2001).

Our work in the John Day Dam tailrace during 2000 (Duran et al. 2002) suggested that fish passing through the juvenile bypass system (JBS) during high spill discharge (60% spill) had extended tailrace egress times. Egress times were reduced during low spill discharge (30% spill). The objective of this study was to describe the behavior of radio-tagged hatchery yearling and subyearling Chinook salmon and wild yearling steelhead released through the JBS under different spill regimes to determine their egress time and travel routes.

METHODS

Test Conditions

Dam operating conditions are reported according to local convention: discharge in units of thousand cubic feet per second (kcfs) and tailwater elevation in feet. Proposed spill conditions were either 0% during the day and 60% at night (12 – h spill) or 30% during the day and 30% at night (24 – h spill), assigned in a randomized block design. Each 4-day block contained 2 days of each condition. Operational changes were made daily at 0700 h and 1800 h. Study fish were released during the 30% night and the 60% night spill conditions.

Study Design

This study was designed to evaluate tailrace egress by describing the movements of fish passing into the tailrace through the JBS. During the spring outmigration, hatchery yearling Chinook salmon *(Oncorhynchus tshawytscha)* and wild juvenile steelhead *(O. mykiss)* were monitored. Hatchery subyearling Chinook salmon *(O. tshawytscha)* were evaluated during the summer outmigration. The study plan was to release equal numbers of fish under each of the two test conditions (30% night and 60% night spill). Radio-tagged fish were released into the JBS near the Smolt Monitoring Facility, approximately 200 m upriver of the outfall. Releases began at 1900 h to allow tailrace conditions to stabilize following the daily operational change.

Fish Collection, Tagging, and Release

Juvenile salmonids (yearling Chinook salmon, steelhead, and subyearling Chinook salmon) were collected at the Smolt Monitoring Facility at JDA, and held 12-24 h in 0.8 m diameter circular tanks. Due to insufficient collection numbers of steelhead for some planned

release dates, some steelhead experienced a prolonged holding period up to 48 h. Radio transmitters implanted in hatchery yearling Chinook salmon and wild juvenile steelhead were 7.3 mm x 18 mm and weighed 1.4 g in air (Lotek Wireless model 3KM). Radio transmitters implanted in subyearling Chinook salmon were 6.3 mm x 4.5 mm x 14.5 mm and weighed 0.85 g in air (Lotek Wireless model NTC-3-1). Gastric implantation methods were as described in Martinelli et al. (1998). Tagged fish were held for approximately 24 h before release.

Fish were released into the JBS in groups of two. On each release date, fish were released in batches separated by approximately 30 minutes to allow the previous group of fish to exit the immediate tailrace area. Limiting the number of study fish in the tailrace allowed collection of fine-scale movement data by boat tracking.

Monitoring

A combination of fixed-site receiving stations (fixed stations) and boat tracking were used to monitor radio-tagged fish. Methods for fixed stations were as described by Liedtke et al. (2001) and boat-tracking methods were as described in Hensleigh et al. (1999). Monitoring sites were located directly upriver of the JBS outfall, at the tip of the navigation lock (Exit 1), the dredge island (Exit 2) located 1.9 km downriver of the dam, and an exit site 5.3 km from the dam (Exit 3; Figure 1).

Boat tracking was used to collect fine-scale movement data within the tailrace. Once a fish was detected at close range (15-30 m), the location was recorded using a Global Positioning System receiver. Most of the tracking effort was concentrated between the JBS outfall and Exit 1. No tracking was performed in front of the spillway outflow due to safety constraints. If a fish entered the spillway outflow, the tracking boats would wait at the interface of the spillway and

the powerhouse and continue monitoring if possible. Boat tracking was used to collect as many locations as possible on individual fish to get route information, supplement fixed station data in determining exit times, verify suspected predation events, and determine dredge island passage routes.

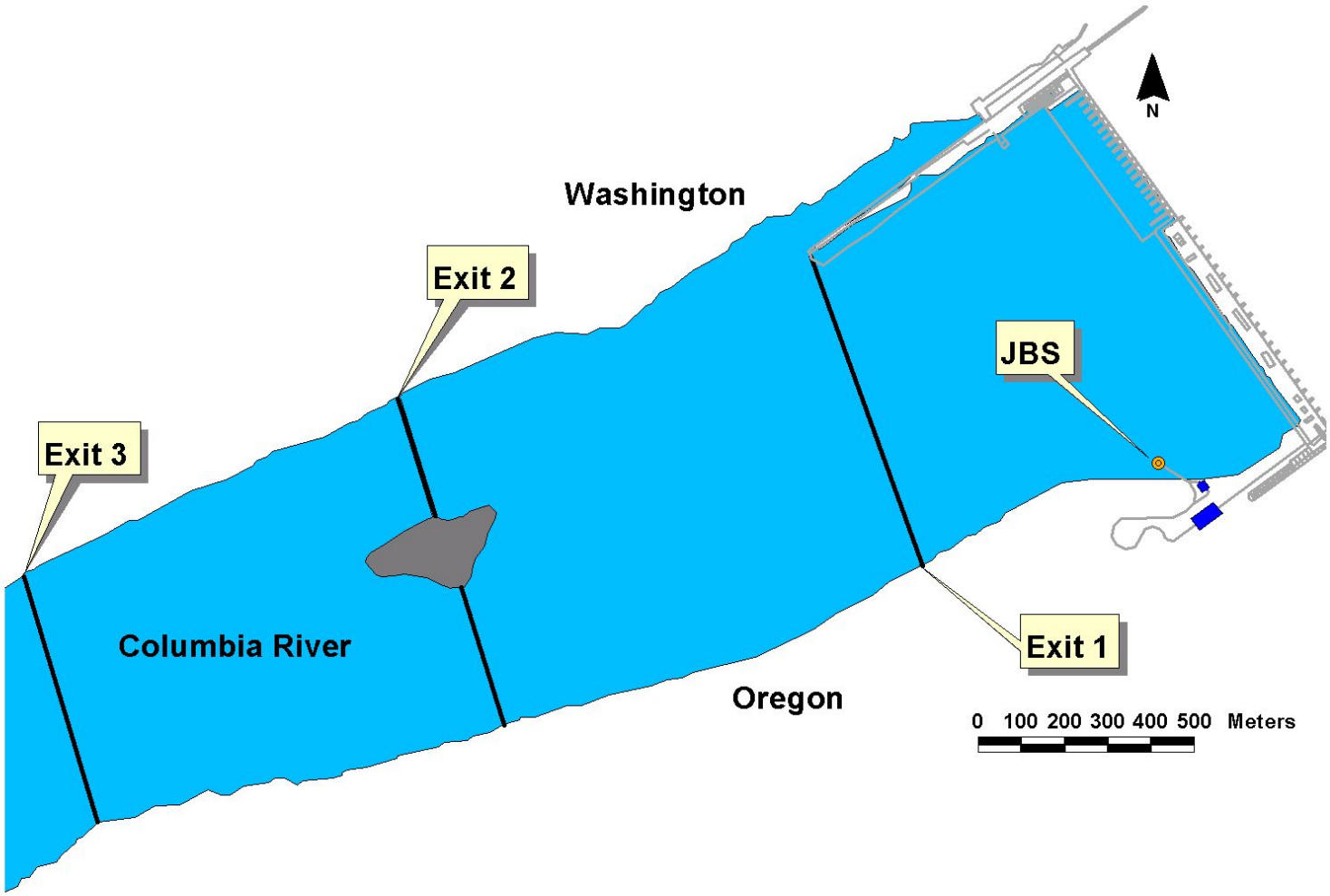

Figure 1. John Day Dam tailrace study area, 2002. Monitoring sites were located directly upriver of the JBS outfall, at the tip of the navigation lock (Exit 1), the dredge island (Exit 2) located 1.9 km downriver of the dam, and an exit site 5.3 km from the dam (Exit 3).

Data Analysis

Fixed receivers were typically downloaded every other day. All data was backed up on the day of download and imported into SAS (version 8.1, SAS Institute Inc., Cary, North

Carolina, USA) for proofing and analysis. Boat tracking data was imported into ArcView GIS (version 3.3, Environmental Systems Research Institute Inc., Redlands, California, USA) for geospatial analysis and graphical output. Data were manually proofed to eliminate non-valid records and identify predation events. For comparison of spill conditions, all releases were pooled according to the proposed spill condition during which that release occurred. Spill data are based upon actual spill conditions experienced during the study period, and were summarized using hourly dam operations 1 h before release time and 11 h afterwards.

Travel times were calculated from the time of release to the time of detection at each of the three exit stations. All travel time data were analyzed with nonparametric statistical methods. We present medians with ranges, and used the Kruskal-Wallis test of medians for comparisons. All findings with $P \leq 0.05$ were considered statistically significant.

A hypothetical spillway zone was identified as the area occupied by the width of the spillway and skeleton bays (approximately 500 m), and extending approximately 1,250 m downriver of the dam. Fish that demonstrated a movement path into the spillway outflow with at least one location within the zone will hereafter be referred to as "spillway fish". Fish that had three or more locations determined by boat tracking were considered to have known travel paths. Fish with less than three locations were omitted from analysis. Graphical depictions of travel routes may appear erratic, primarily due to limited boat operation in front of the spillway due to safety constraints.

Volitionally-Passed Fish

Radio-tagged fish released for survival studies at JDA were also monitored for egress in the tailrace of JDA. Fish for the survival study were released at Rock Creek, WA, approximately

23 km upstream of JDA and could pass the dam through any route. These fish are referred to as "volitionally-passed fish" and represent the best surrogates for run-of-the-river fish. Fish were monitored for route of passage and egress through the tailrace. The large quantity of frequencies needed at JDA restricted our ability to monitor all frequencies at all fixed sites. Subsequently, these fish were monitored at fixed sites located on the face of the dam, the JBS outfall, and Exit 3 (Figure 1). Travel times were calculated from the time the fish were detected within the JDA tailrace to the time of their last detection at Exit 3.

Travel time from spillway passage to Exit 3 was determined for fish volitionally passing JDA through the spillway during planned 30% day, 30% night, and 60% night spill conditions. These fish were also monitored for delay and predation at an eddy site located along the exterior navigation lock wall. To examine potential site effects within the spillway, we compared the egress of fish passing the north and south halves of the spillway.

RESULTS

YEARLING FISH

Dam Operating Conditions

Dam operating conditions during the study period varied from planned conditions. Total discharge during releases ranged from 162 to 295 kcfs with a mean of 238 kcfs (Table 1). Yearling Chinook salmon and juvenile steelhead releases during proposed 30% spill had actual spill that ranged from 28% to 35%, with a mean of 30% spill. Releases during proposed 60% spill had actual spill that ranged from 52% to 59%, with a mean of 57% spill. The mean spill discharge was 68 kcfs during 30% spill releases, and 142 kcfs during 57% spill (Table 1). Tailrace elevation remained relatively constant during the study period; mean of 161.3 ft during 30% spill and mean of 161.4 ft during 57% spill (Table 1). Appendices 1, 2, and 3 depict hourly dam operations for all fish release dates.

Table 1. Dam operating conditions during the dates radio-tagged hatchery yearling Chinook salmon and wild juvenile steelhead were released at John Day Dam, spring 2002. The total discharge, spill discharge, and tailrace elevation are the mean hourly discharges for the period starting one hour before each release and continuing for 11 hours after each release. Data were collected from http://www.nwd-wc.usace.army.mil/TMT.

Planned % Spill	Release Date	Total Discharge (kcfs)	Spill kcfs (%)	Tailrace Elevation (ft)
30	5/02	241.4	85.2 (35.3)	161.7
30	5/10	201.6	60.8 (30.1)	161.1
30	5/12	161.8	49.5 (30.6)	159.7
30	5/18	219.3	65.3 (29.8)	160.9
30	5/20	253.7	74.9 (29.5)	162.1
30	5/26	215.0	63.8 (29.7)	160.4
30	5/28	277.7	78.7 (28.3)	163.0
30	**Mean**	224.3	68.3 (30.5)	161.3
60	5/06	242.6	139.4 (57.4)	161.0
60	5/08	244.5	141.7 (57.9)	161.5
60	5/14	200.2	118.7 (59.3)	160.0
60	5/16	226.4	133.4 (58.9)	160.9
60	5/22	279.4	153.7 (55.0)	161.9
60	5/24	275.6	153.4 (55.7)	161.6
60	5/30	294.9	153.8 (52.1)	162.9
60	**Mean**	251.9	142.0 (56.6)	161.4

Tagging and Release

A total of 93 radio-tagged hatchery yearling Chinook salmon and 88 radio-tagged wild juvenile steelhead were released through the JBS between 2 May and 30 May 2002. Each of the 14 releases were conducted between approximately 1900 hours and 0200 hours. The spring study period coincided with the central portion of the migration period of yearling Chinook salmon and juvenile steelhead (Figure 2). Mean fork lengths and weights of fish are presented in Tables 2 and 3. The radio tag represented 4.2% of mean fish body weight for yearling Chinook salmon and 2.2% of mean fish body weight for juvenile steelhead. Of the 98 yearling Chinook salmon tagged, 1 (1.0%) regurgitated its tag and 4 (4.1%) died during the 24-h holding period. Of the 92 juvenile steelhead tagged, 4 (4.3%) regurgitated their tags and there were no mortalities.

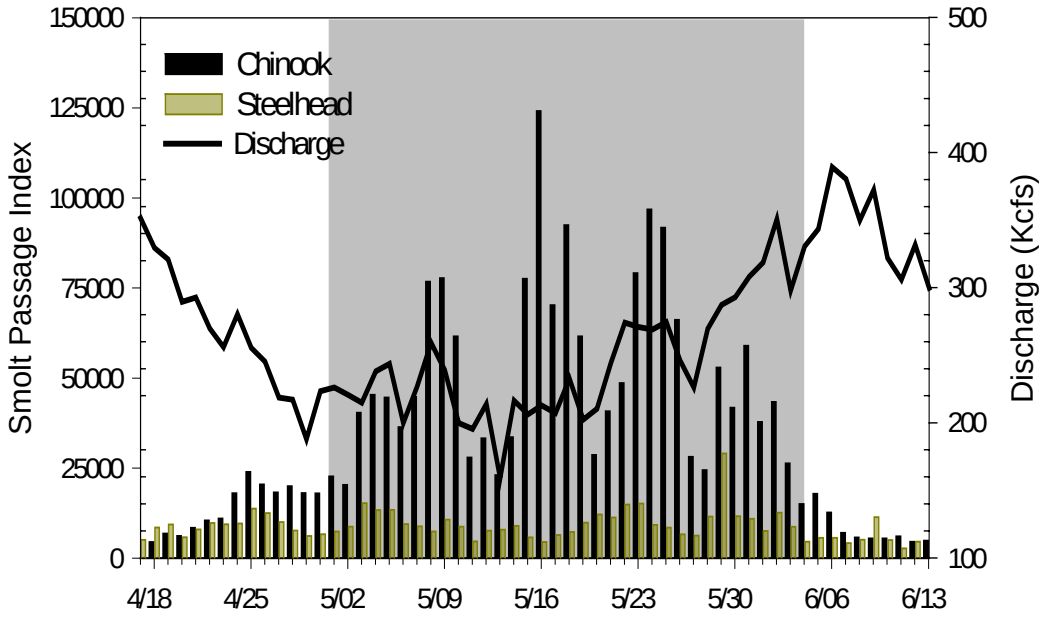

Figure 2. Smolt passage index for yearling Chinook salmon and juvenile steelhead at John Day Dam's smolt monitoring facility during spring 2002. Shaded area represents the study period. Discharge represents total river flow at John Day Dam. Smolt index data were acquired from the Fish Passage Center web page at http://www.fpc.org.

Table 2. Fork lengths and weights of yearling Chinook salmon released through the juvenile bypass system during 30% and 57% spill at John Day Dam, spring 2002.

Release			Fork length (mm)		Weight (g)	
Date	Spill	*N*	Mean	Range	Mean	Range
05/02/02	30%	6	146	136 - 156	31.0	24.8 - 37.4
05/10/02	30%	6	132	123 - 140	21.7	17.8 - 25.1
05/12/02	30%	6	145	136 - 161	30.1	22.9 - 42.0
05/18/02	30%	8	157	136 - 205	39.8	22.3 - 76.8
05/20/02	30%	7	151	128 - 186	32.3	18.2 - 53.3
05/26/02	30%	7	148	135 - 163	29.0	22.1 - 40.9
05/28/02	30%	8	168	156 - 188	43.4	33.9 - 62.9
Overall	30%	48	151	123 - 205	33.1	17.8 - 76.8
05/06/02	57%	6	148	135 - 170	30.6	21.5 - 44.1
05/08/02	57%	5	162	150 - 177	40.5	32.3 - 54.6
05/14/02	57%	5	145	138 - 150	30.0	22.3 - 34.3
05/16/02	57%	8	146	135 - 166	29.4	22.5 - 45.8
05/22/02	57%	8	143	118 - 165	28.0	16.1 - 45.2
05/24/02	57%	6	159	125 - 185	39.1	18.4 - 54.9
05/30/02	57%	7	158	145 - 176	34.2	28.2 - 47.7
Overall	57%	45	151	118 - 185	32.7	16.1 - 54.9
Total		**93**	**151**	**118 - 205**	**33.0**	**16.1 – 76.8**

Table 3. Fork lengths and weights of juvenile steelhead released through the juvenile bypass system during 30% and 57% spill releases at John Day Dam, spring 2002.

Release			Fork length (mm)		Weight (g)	
Date	Spill	*N*	Mean	Range	Mean	Range
05/02/02	30%	5	191	174 - 217	63.7	47.9 - 92.3
05/10/02	30%	5	189	160 - 220	62.6	34.6 - 105.2
05/12/02	30%	6	182	156 - 210	55.8	32.8 - 79.0
05/18/02	30%	7	187	161 - 205	60.6	33.9 - 84.4
05/20/02	30%	7	202	169 - 240	72.9	36.4 - 115.0
05/26/02	30%	8	186	167 - 215	59.1	41.3 - 90.1
Overall	30%	38	190	156 - 240	62.5	32.8 - 115.0
05/06/02	57%	6	190	170 - 244	62.0	44.2 - 119.4
05/08/02	57%	6	186	170 - 210	60.2	45.2 - 84.4
05/14/02	57%	6	181	170 - 190	52.7	40.4 - 61.5
05/16/02	57%	8	190	159 - 225	63.8	40.1 - 101.0
05/22/02	57%	8	191	175 - 226	66.9	51.2 - 113.4
05/24/02	57%	8	202	184 - 225	69.8	50.1 - 88.7
05/30/02	57%	8	196	169 - 230	61.5	38.5 - 92.4
Overall	57**%**	50	192	159 - 244	62.9	38.5 - 119.4
Total		**88**	**191**	**156 - 244**	**63.0**	**32.8 - 119.4**

Travel Time to Exit Stations

The median travel times of both species to Exit 1 were significantly greater during 57% spill than during 30% spill ($P < 0.0001$; Figures 3 and 4). The median travel time of yearling Chinook salmon and juvenile steelhead to Exit 1 at 57% spill was double that at 30% spill (Table 4). Differences in median travel times to Exit 2 during 30% and 57% spill releases were not significant for yearling Chinook salmon ($P = 0.06$; Figure 3), but were significant for juvenile steelhead ($P = 0.001$; Figure 4). Fish reached Exit 2 within 22-33 minutes after release (Table 4). The influence of spill condition on travel time to Exit 3 was larger for yearling Chinook salmon than for juvenile steelhead. Median travel times to Exit 3 for yearling Chinook salmon were significantly different during 30% spill and 57% spill ($P = 0.04$; Figure 3). Spill had a small effect on the travel times of juvenile steelhead ($P = 0.23$; Figure 4). Travel time to Exit 3 was 81-93 minutes following release (Table 4).

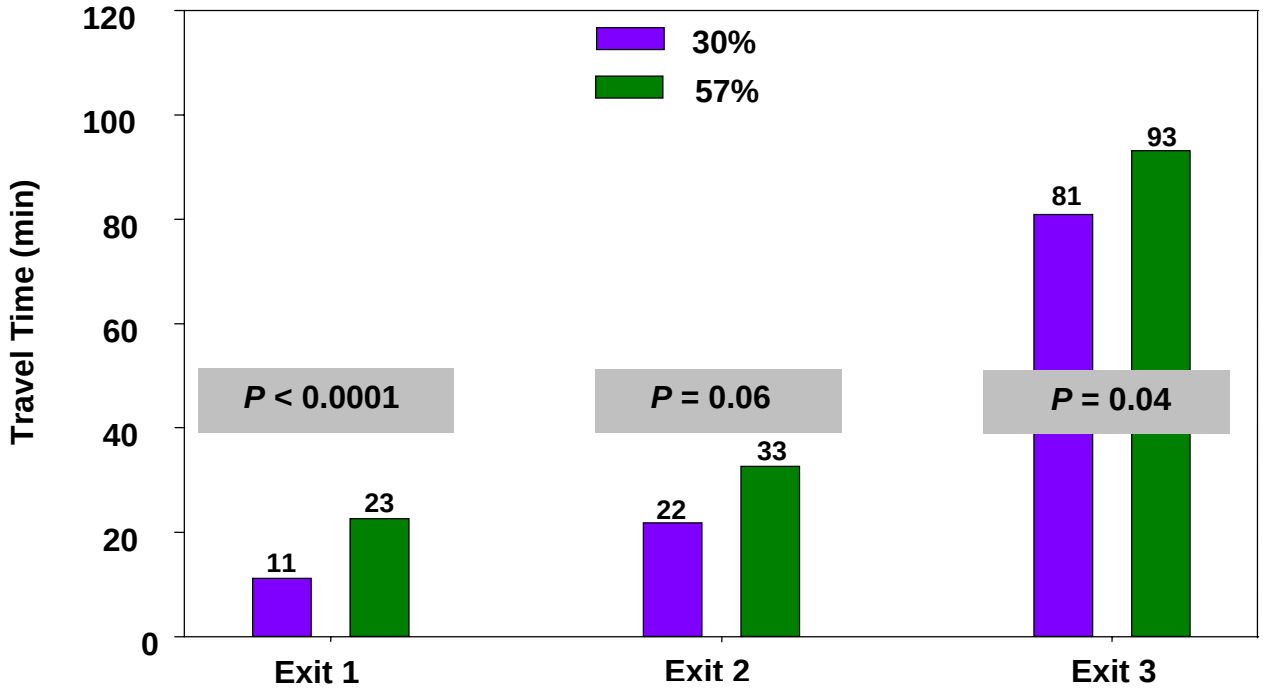

Figure 3. Median travel times of hatchery yearling Chinook salmon during 30% and 57% night spill at John Day Dam, spring 2002. Travel times were measured from time of release through the juvenile bypass system to the time of the last detection at three stations: the boat-restricted zone line (Exit 1), the dredge island located 1.9 km downriver of the dam (Exit 2), and a point 5.3 km downriver of the dam (Exit 3). Sample sizes reflect those shown in Table 1. Each pair of bars was compared using a Kruskal-Wallis test and the P-value is presented for each pair. Actual values are shown on top of bars.

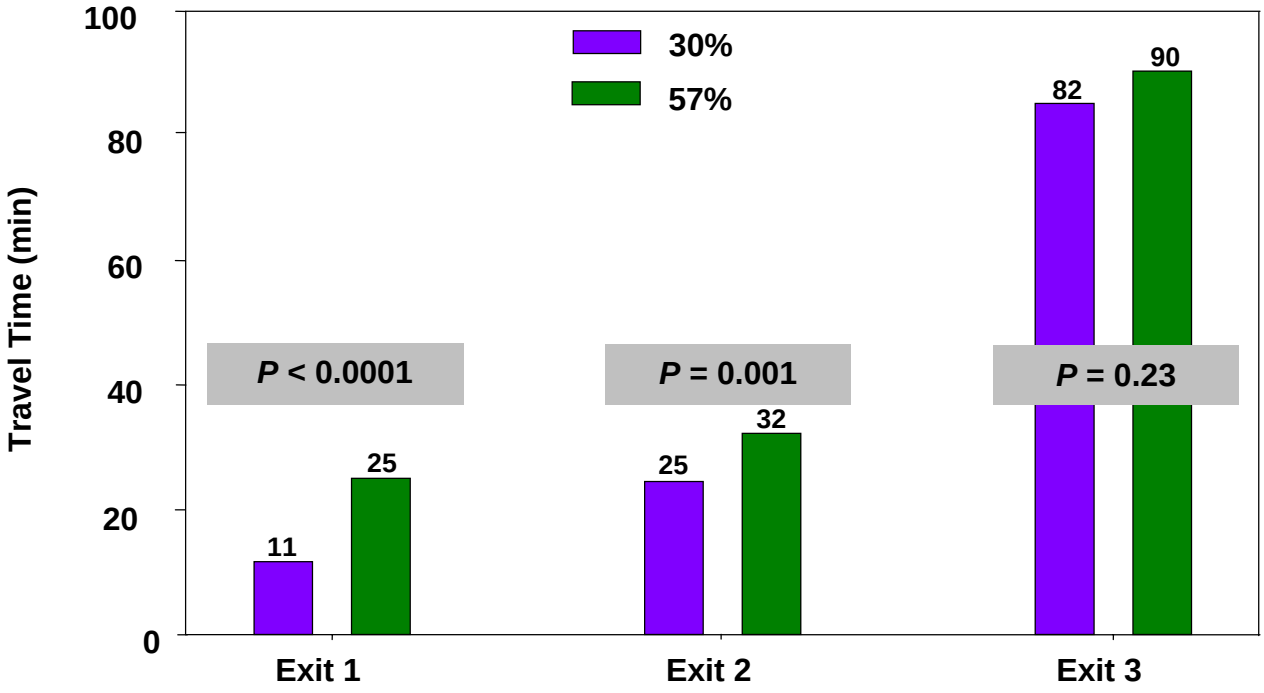

Figure 4. Median travel times of wild juvenile steelhead during 30% and 57% night spill at John Day Dam, spring 2002. Travel times were measured from time of release through the juvenile bypass system to the time of the last detection at three stations: the boat-restricted zone line (Exit 1), the dredge island located 1.9 km downriver of the dam (Exit 2), and a point 5.3 km downriver of the dam (Exit 3). Sample sizes reflect those shown in Table 1. Each pair of bars was compared using a Kruskal-Wallis test and the P-value is presented for each pair. Actual values are shown on top of bars.

Table 4. Travel times (TT) of hatchery yearling Chinook salmon (CH1) and wild juvenile steelhead (STHD) during 30% spill (A) and 57% spill (B) at John Day Dam, spring 2002. All releases were conducted at night through the juvenile bypass system. Travel times were measured from time of release to the time of last detection at three receiving stations: the boat-restricted zone line located 0.7 km downriver of the dam (Exit 1), the dredge island located 1.9 km downriver of the dam (Exit 2), and a point 5.3 km downriver of the dam (Exit 3).

A. 30 % Spill

Release date	Species	Number released	TT from release to Exit 1 (min)			TT from release to Exit 2 (min)			TT from release to Exit 3 (min)		
			N	Median	Range	*N*	Median	Range	*N*	Median	Range
5/02	CH1	6	0	---	---	0	---	---	3	71.1	65.2 - 86.4
5/10	CH1	6	2	11.9	11.2 - 12.7	1	29.4	29.4 - 29.4	6	87.2	81.1 - 92.2
5/12	CH1	6	6	14.4	0.1 - 37.6	3	34.4	28.3 - 39.1	6	111.6	103.1 - 148.2
5/18	CH1	8	8	14.8	11.8 - 18.3	2	23.4	21.8 - 25.1	6	86.0	68.7 - 101.5
5/20	CH1	7	7	8.0	6.9 - 12.0	4	17.8	17.3 - 18.2	6	69.6	59.2 - 91.4
5/26	CH1	7	6	11.4	9.9 - 54.2	5	22.4	18.2 - 69.5	7	75.6	65.3 - 125.5
5/28	CH1	8	8	9.6	8.2 - 13.8	2	17.4	15.3 - 19.6	8	65.3	60.6 - 79.5
Overall	CH1	48	37	11.2	0.1 - 54.2	17	21.8	15.3 - 69.5	42	80.9	59.2 - 148.2
5/02	STHD	5	0	---	---	0	---	---	4	92.8	68.3 - 112.8
5/10	STHD	5	1	11.7	11.7 - 11.7	2	27.1	24.6 - 29.6	4	94.9	75.5 - 104.8
5/12	STHD	6	4	11.0	0.4 - 16.4	4	29.6	26.8 - 38.5	4	95.4	88.9 - 109.1
5/18	STHD	7	6	12.1	11.0 - 14.3	0	---	---	6	91.0	73.0 - 104.2
5/20	STHD	7	7	11.5	8.8 - 13.8	6	22.4	16.2 - 23.1	6	63.8	59.9 - 73.1
5/26	STHD	8	7	13.5	11.0 - 21.4	5	25.4	20.1 - 33.0	6	82.1	69.4 - 148.6
Overall	STHD	38	25	11.7	0.4 - 21.4	17	24.6	16.2 - 38.5	30	85.2	59.9 - 148.6

B. 57 % Spill

Release date	Species	Number released	TT from release to Exit 1 (min)			TT from release to Exit 2 (min)			TT from release to Exit 3 (min)		
			N	Median	Range	*N*	Median	Range	*N*	Median	Range
5/06	CH1	6	2	32.5	22.5 - 42.6	0	---	---	5	118.1	109.7 - 169.8
5/08	CH1	5	5	13.9	0.1 - 52.8	0	---	---	4	101.5	70.1 - 156.5
5/14	CH1	5	0	---	---	0	---	---	1	161.5	161.5 - 161.5
5/16	CH1	8	6	55.4	20.5 - 119.7	3	69.0	32.6 - 82.7	6	133.2	107.8 - 157.8
5/22	CH1	8	5	24.3	18.4 - 35.1	1	47.5	47.5 - 47.5	7	81.0	70.0 - 97.9
5/24	CH1	6	4	22.1	14.7 - 24.7	1	32.8	32.8 - 32.8	5	80.6	73.6 - 95.2
5/30	CH1	7	6	11.8	11.4 - 14.6	3	20.5	18.8 - 22.8	6	60.6	56.0 - 108.3
Overall	CH1	45	28	22.6	0.1 - 119.7	8	32.7	18.8 - 82.7	34	93.1	56.0 - 169.8
5/06	STHD	6	3	17.5	0.6 - 19.4	0	---	---	5	83.8	72.5 - 107.5
5/08	STHD	6	4	31.1	21.8 - 199.2	0	---	---	3	109.0	101.2 - 322.4
5/14	STHD	6	5	65.3	42.5 - 164.7	0	---	---	4	119.1	69.0 - 246.1
5/16	STHD	8	3	52.9	40.0 - 80.4	0	---	---	5	106.1	86.5 - 161.9
5/22	STHD	8	5	26.7	18.0 - 58.4	4	33.2	25.6 - 67.6	6	77.1	68.5 - 105.9
5/24	STHD	8	8	22.7	15.5 - 114.5	5	29.6	28.0 - 96.8	7	70.5	63.7 - 189.3
5/30	STHD	8	4	18.5	14.2 - 22.0	4	39.2	28.1 - 65.8	5	78.0	67.9 - 114.7
Overall	STHD	50	32	25.1	0.6 - 199.2	13	32.3	25.6 - 96.8	35	90.4	63.7 - 322.4

Travel Rates

The lowest travel rate for both species occurred between the JBS outfall and Exit 1 during 57% spill. Yearling Chinook salmon released through the JBS had a median travel rate to Exit 1 that was twice as fast during 30% spill (3.6 km/h) than during 57% spill (1.8 km/h; Table 5). Juvenile steelhead had travel rates to Exit 1 similar to that of yearling Chinook salmon (Table 5). Travel rates between Exit 1 and Exit 2 were the most variable (Table 5) for both species. During 57% spill, both yearling Chinook salmon and juvenile steelhead had higher travel rates from Exit 2 to Exit 3 (4.3 and 5.0 km/h) than during 30% spill (3.9 km/h; Table 5).

Table 5. Travel rates (TR) for hatchery yearling Chinook salmon (CH1) and wild juvenile steelhead (STHD) during 30% and 57% spill at John Day Dam, spring 2002. All releases were conducted at night through the juvenile bypass system. Travel rates were calculated using detections from three fixed stations: the boat-restricted zone line located 0.7 km downriver of the dam (Exit 1), the dredge island located 1.9 km downriver of the dam (Exit 2), and a point 5.3 km downriver of the dam (Exit 3).

		TR from release to Exit 1 (km/h)			TR from Exit 1 to Exit 2 (km/h)			TR from Exit 2 to Exit 3 (km/h)		
% Spill	Species	*N*	Median	Range	*N*	Median	Range	*N*	Median	Range
30	CH1	35	3.6	0.8 - 6.1	17	7.6	1.9 - 12.0	17	3.9	1.9 - 4.8
	STHD	24	3.5	2.0 - 5.0	15	6.4	1.9 - 10.6	15	3.9	2.7 - 5.5
57	CH1	27	1.8	0.4 - 3.7	8	7.3	5.8 - 10.4	7	4.3	2.5 - 5.4
	STHD	31	1.6	0.2 - 3.0	9	7.8	5.8 - 10.7	10	5.0	4.2 - 6.0

Travel Routes

Boat tracking was used to monitor individual fish movements within and downriver of the BRZ. During 30% spill, 331 fish locations were recorded, representing 40 individual yearling Chinook salmon and 26 individual juvenile steelhead (Figure 5). During 57% spill, 296 fish locations were recorded, representing 26 individual yearling Chinook salmon and 31 individual juvenile steelhead (Figure 6). Locations were plotted on a map of the river to determine routes of travel for individual fish. Figures 7 and 8 depict representative routes of

travel for yearling Chinook salmon and juvenile steelhead that exhibited travel times ± 1 min of the median travel time during 30% spill. Figures 9 and 10 depict representative travel routes of yearling Chinook salmon and juvenile steelhead that exhibited travel times closest to the median travel time during 57% spill. A typical travel route of a fish released through the JBS involved the fish making an arc initially toward the spillway outflow then toward the southern shoreline, following the contours of the shoreline as it moved downriver. Routes of travel for all individual yearling Chinook salmon and juvenile steelhead tracked during each spill condition are presented in Appendix 4.

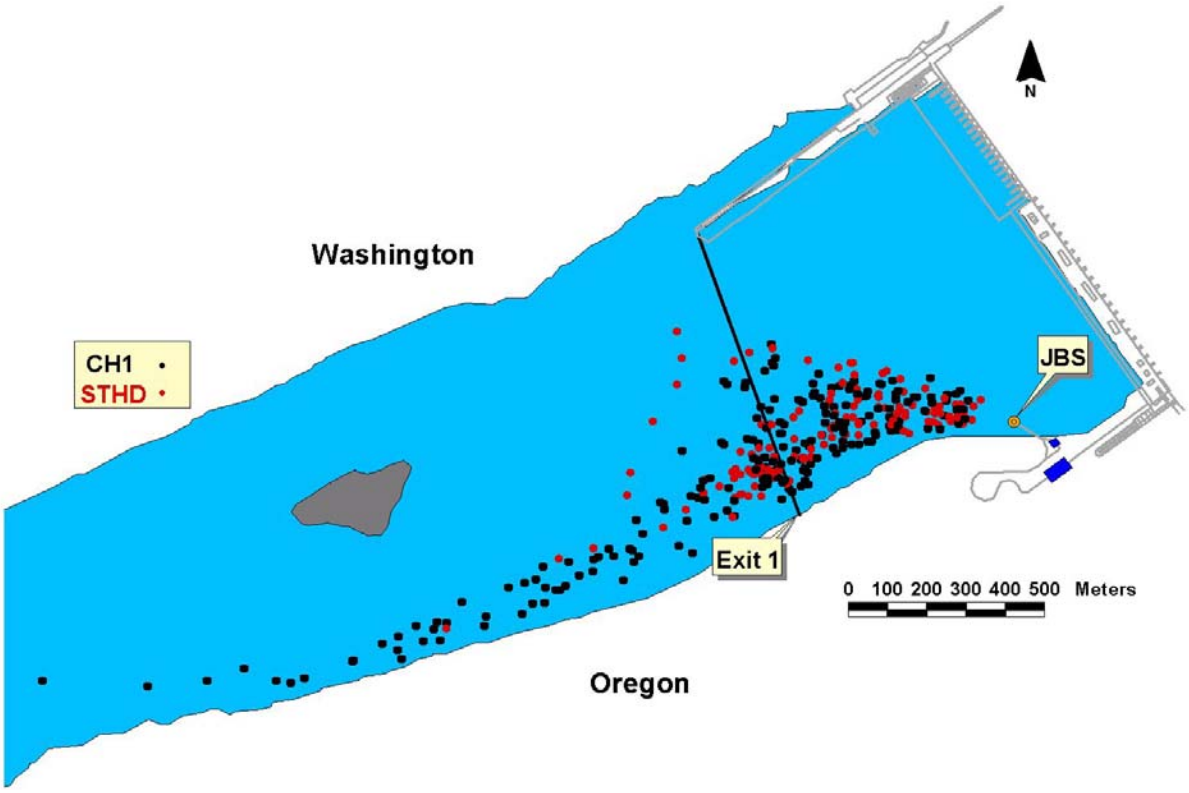

Figure 5. Locations of hatchery yearling Chinook salmon (CH1) and wild juvenile steelhead (STHD) released through the juvenile bypass system during 30% spill at John Day Dam, spring 2002. Each point represents a fish location collected via boat tracking. Chinook detections total 204 locations, representing 40 individual fish. Steelhead detections total 127 locations, representing 26 individual fish.

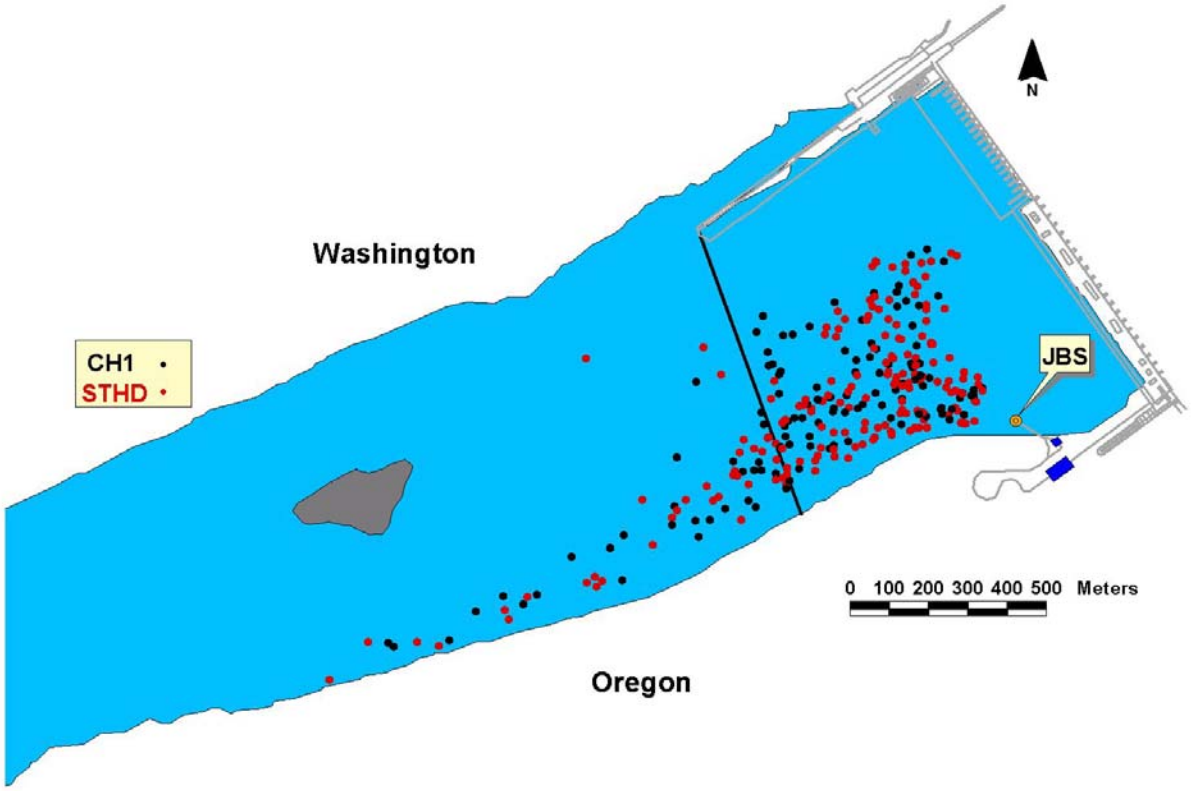

Figure 6. Locations of hatchery yearling Chinook salmon (CH1) and wild juvenile steelhead (STHD) released through the juvenile bypass system during 57% spill at John Day Dam, spring 2002. Each point represents a fish location collected via boat tracking. Chinook detections total 119 locations, representing 26 individual fish. Steelhead detections total 177 locations, representing 31 individual fish.

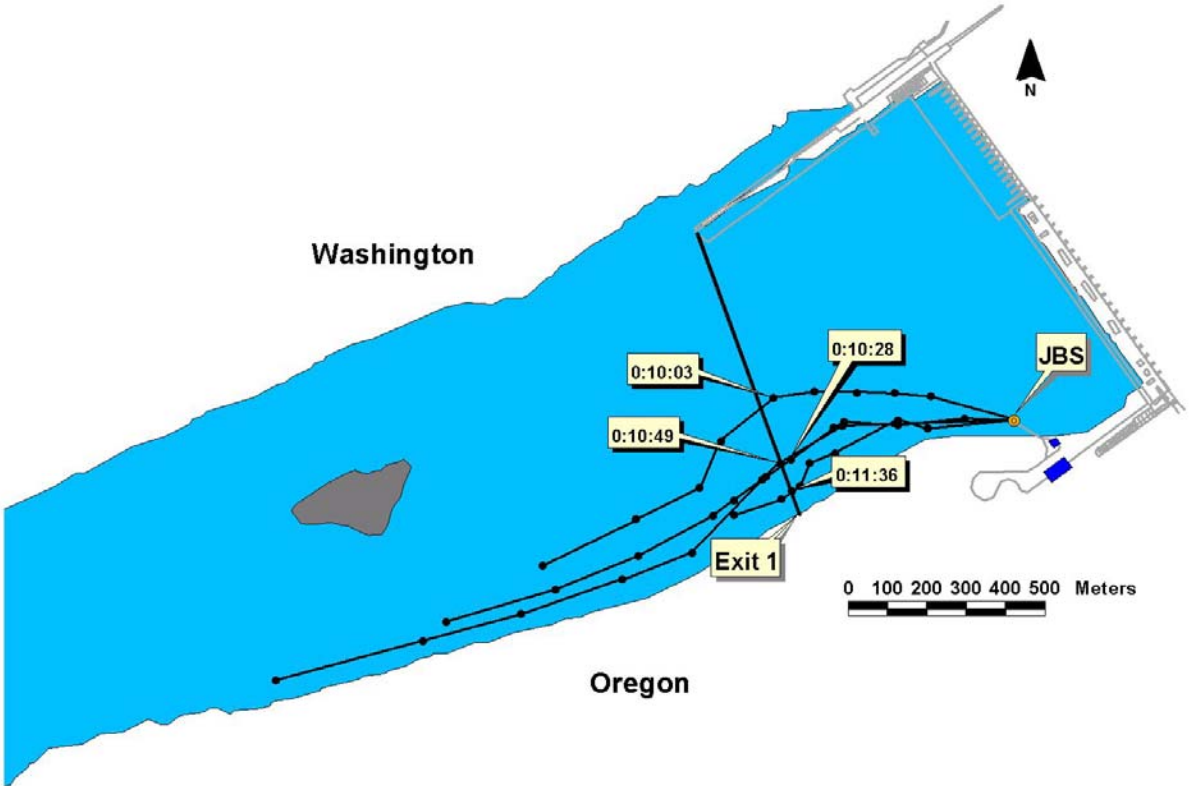

Figure 7. Representative travel routes of hatchery yearling Chinook salmon released through the juvenile bypass system during 30% spill at John Day Dam, spring 2002. Times represent total travel time from release to Exit 1. These fish exhibited travel times ± 1 min of the median travel times in Table 1. Each point represents a fish location collected via boat tracking.

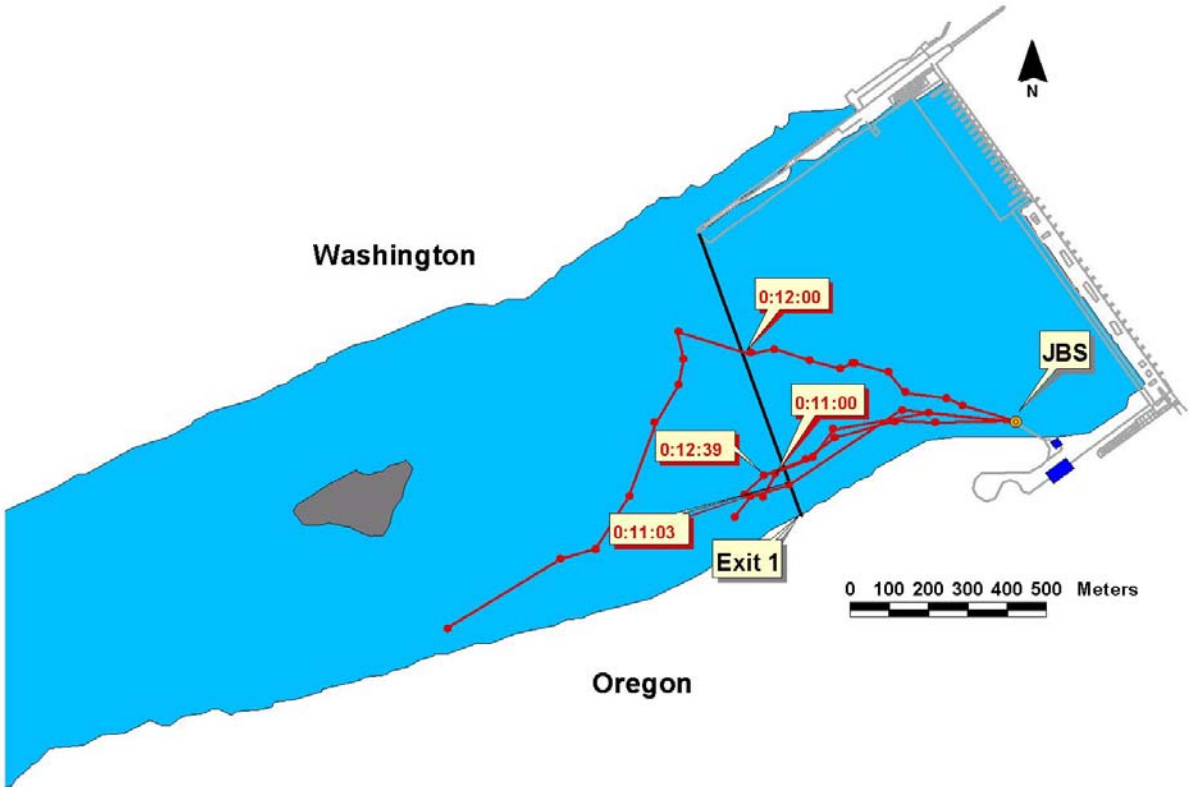

Figure 8. Representative travel routes of wild juvenile steelhead released through the juvenile bypass system during 30% spill at John Day Dam, spring 2002. Times represent total travel time from release to Exit 1. These fish exhibited travel times ± 1 min of the median travel times in Table 1. Each point represents a fish location collected via boat tracking.

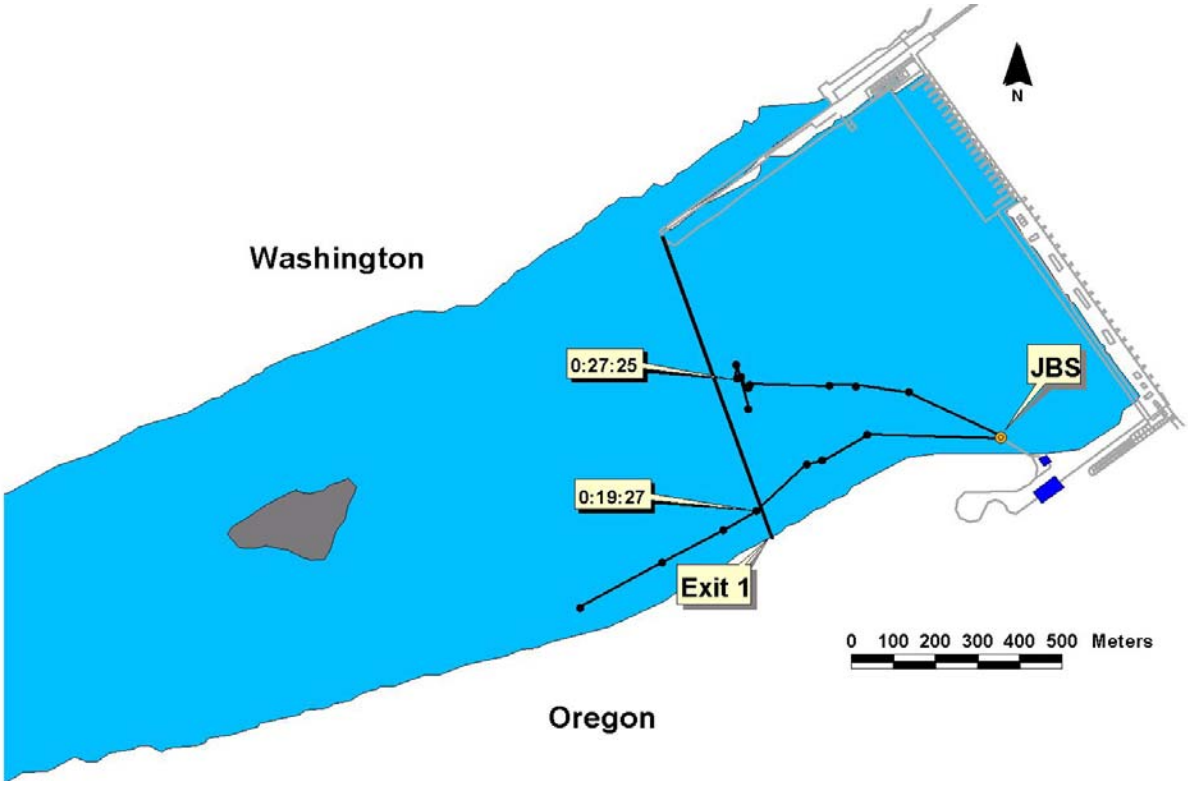

Figure 9. Representative travel routes hatchery yearling Chinook salmon released through the juvenile bypass system during 57% spill at John Day Dam, spring 2002. Times represent total travel time from release to Exit 1. These fish exhibited the closest documented travel times to the median travel times in Table 1. Each point represents a fish location collected via boat tracking.

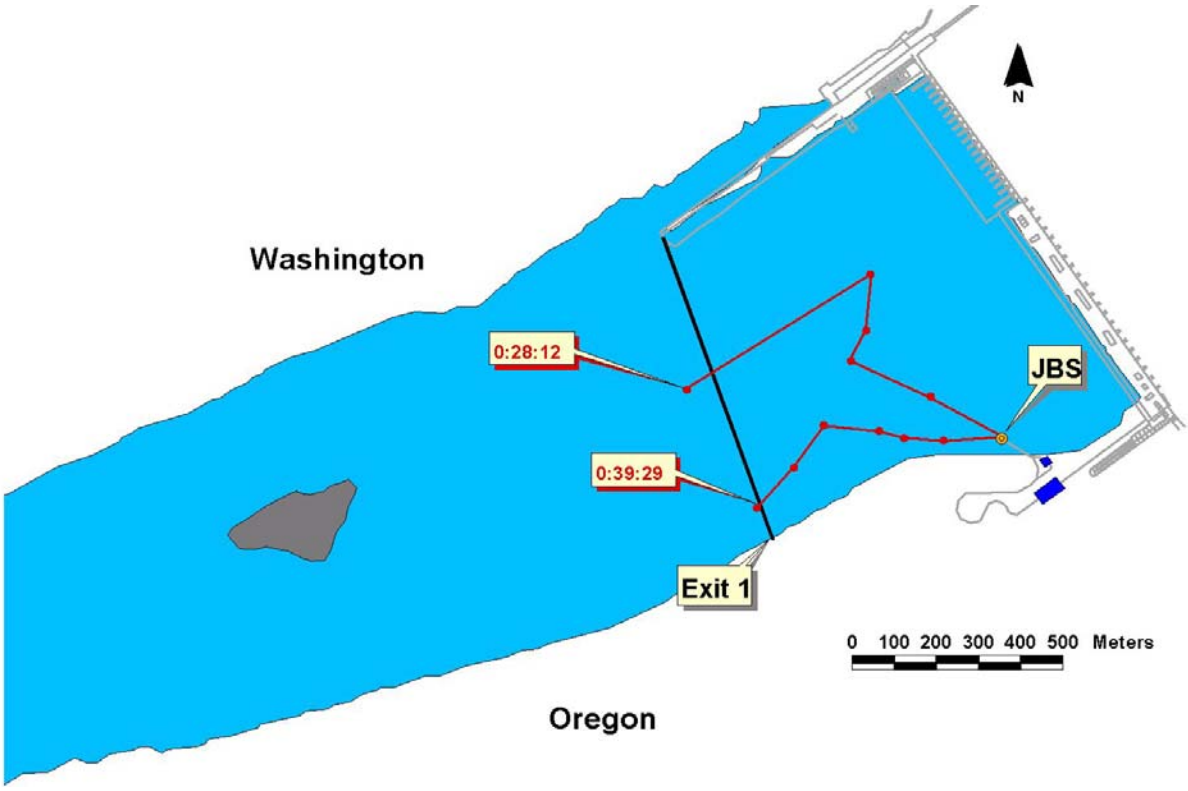

Figure 10. Representative travel routes of wild juvenile steelhead released through the juvenile bypass system during 57% spill at John Day Dam, spring 2002. Times represent total travel time from release to Exit 1. These fish exhibited the closest documented travel times to the median travel times in Table 1. Each point represents a fish location collected via boat tracking.

Dredge Island Passage

The dominant route of passage around the dredge island was in the south channel. Using fixed station data from Exit 2 and boat tracking, we were able to identify the general route of passage taken by radio-tagged fish as they passed the dredge island. Yearling Chinook salmon released from the JBS passed the dredge island on the south side regardless of spill condition. All juvenile steelhead released through the JBS passed the island via the south route during 30% spill, and all but two juvenile steelhead passed south of the island during 57% spill.

Atypical Travel Routes

Radio-tagged fish were detected on the south shore, upriver of the JBS, only during 57% spill. A fixed station monitored fish movements upriver of the JBS outfall because of the potential for fish to delay in this area. No fish were detected within this area during 30% spill conditions. During 57% spill conditions, 4 yearling Chinook salmon (12% of the study fish) and 10 juvenile steelhead (26% of the study fish) were detected (Table 6). Median residence times within this area were between 6 and 7 min (Table 6), and influenced the total travel time in the tailrace. Yearling Chinook salmon that were detected at this site had a 5% delay, and juvenile steelhead had an 11% delay in total travel time (Table 6).

Table 6. Detections of hatchery yearling Chinook salmon (CH1) and wild juvenile steelhead (STHD) that were detected upriver of the juvenile bypass system outfall during 30% and 57% night spill at John Day Dam, spring 2002. Median residence times (RT) were calculated from the time of first detection to the time of last detection at this site. Median RT/TT is reported as the percentage of the total travel time (TT) that a fish was detected upriver of the JBS, and was used as an indicator of delay. Total travel time was measured to Exit 3, a point 5.3 km downriver of the John Day Dam.

% Spill	Species	Number Released	*N* (%) Detected	Median RT (min)	Median RT/TT (%)
30	CH1	30	0 (0.0%)	---	---
	STHD	30	0 (0.0%)	---	---
57	CH1	34	4 (11.8%)	7.6	5.2
	STHD	38	10 (26.3%)	6.5	11.1

Boat tracking efforts within the BRZ identified fish that had atypical travel routes upon exiting the JBS outfall. Some fish traveled on a northern heading and entered the spillway outflow (as defined by our spillway zone). Fish that demonstrated this movement path will hereafter be referred to as spillway fish. During 30% spill conditions, 16% of yearling Chinook salmon ($N = 5$) and 10% of juvenile steelhead ($N = 2$) with known travel paths were identified as spillway fish. During 57% spill conditions, 40% of yearling Chinook salmon ($N = 8$) and 35% of

juvenile steelhead (N = 8) with known travel paths were identified as spillway fish. Travel routes of spillway fish are depicted in Figure 11 (hatchery yearling Chinook salmon) and Figure 12 (wild juvenile steelhead). Graphical depictions of travel routes may appear erratic, primarily due to limited boat operation in front of the spillway due to safety constraints.

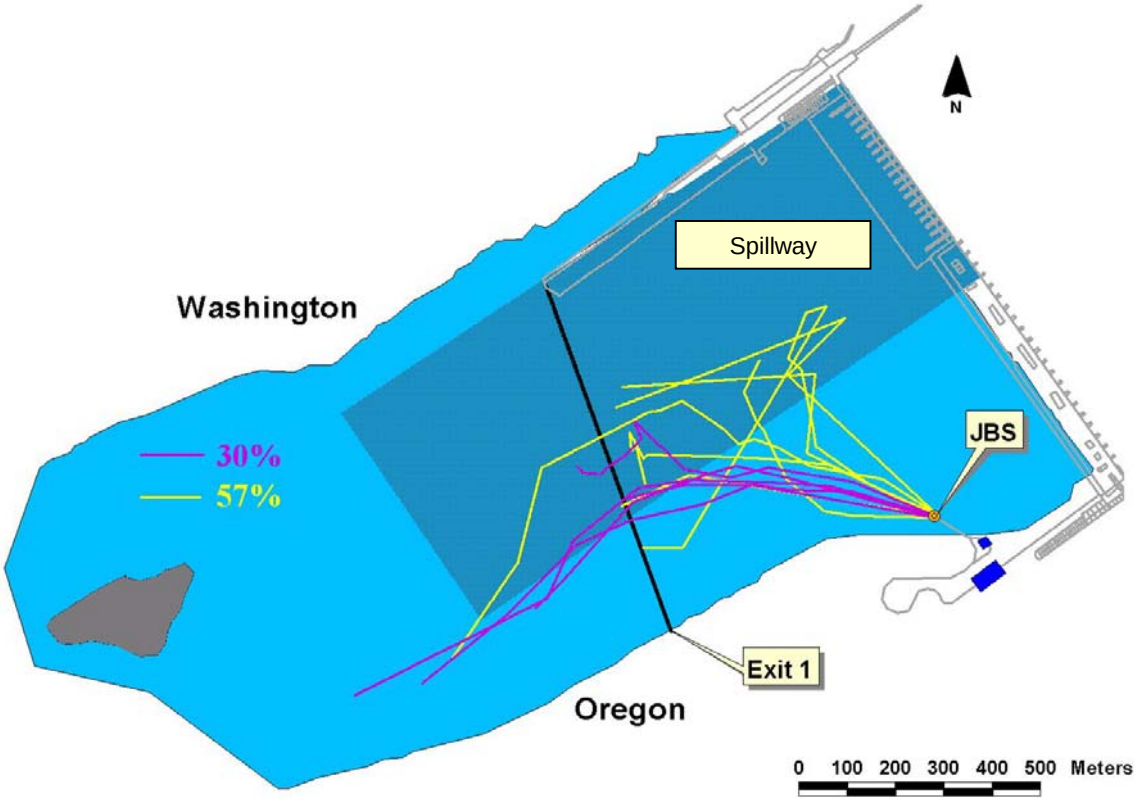

Figure 11. Travel routes of hatchery yearling Chinook salmon released through the juvenile bypass system during 30% and 57% spill at John Day Dam, spring 2002. Each of these travel routes contained one or more documented locations within the spillway zone.

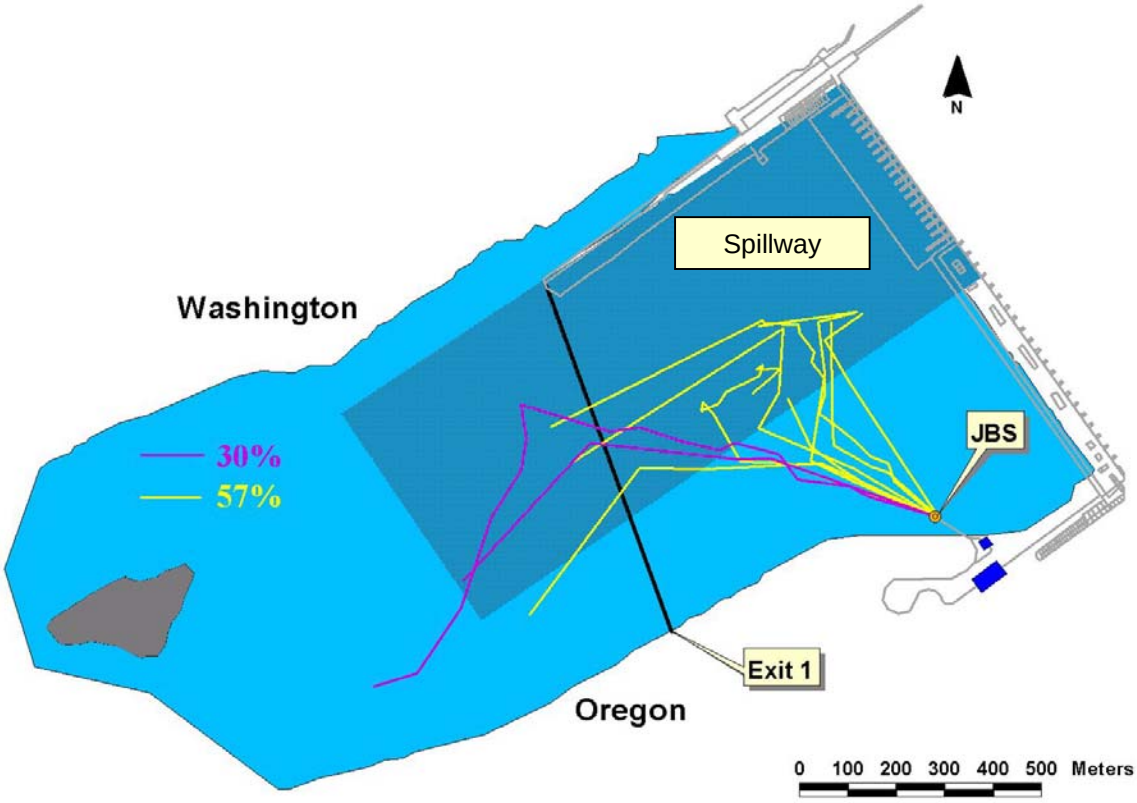

Figure 12. Travel routes of wild juvenile steelhead released through the juvenile bypass system during 30% and 57% spill at John Day Dam, spring 2002. Each of these travel routes contained one or more documented locations within the spillway zone.

Fish that entered the spillway zone had longer travel times than fish that moved directly downriver following release. During 57% spill, the median travel time of yearling Chinook salmon spillway fish was three times longer than that of non-spillway fish ($P = 0.001$; Figure 13). There was no significant difference between the travel times of spillway and non-spillway yearling Chinook salmon during 30% spill conditions (Figure 13). Juvenile steelhead spillway fish exhibited similar patterns, with a median travel time during 57% spill that was nearly twice as long as the median travel time of non-spillway fish ($P = 0.01$; Figure 14). Median travel times during 30% spill conditions for juvenile steelhead spillway fish were not significantly different from non-spillway fish ($P = 0.05$; Figure 14).

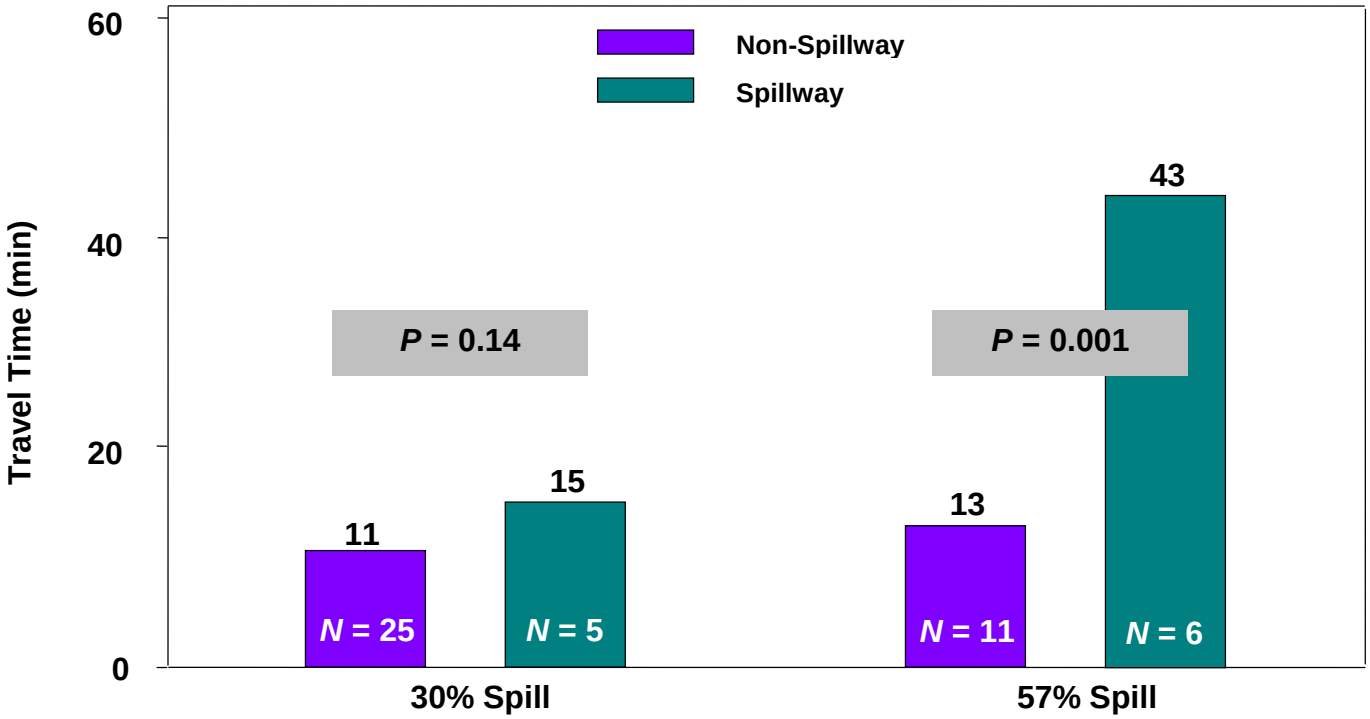

Figure 13. Median travel times of "spillway" zone and "non-spillway" zone hatchery yearling Chinook salmon during 30% and 57% night spill at John Day Dam, spring 2002. Travel times were measured from time of release through the juvenile bypass system to the time of the last detection at Exit 1. Sample sizes are shown in each bar. Each pair of bars was compared using a Kruskal-Wallis test and the *P*-value is presented for each pair. Actual values are shown on top of bars.

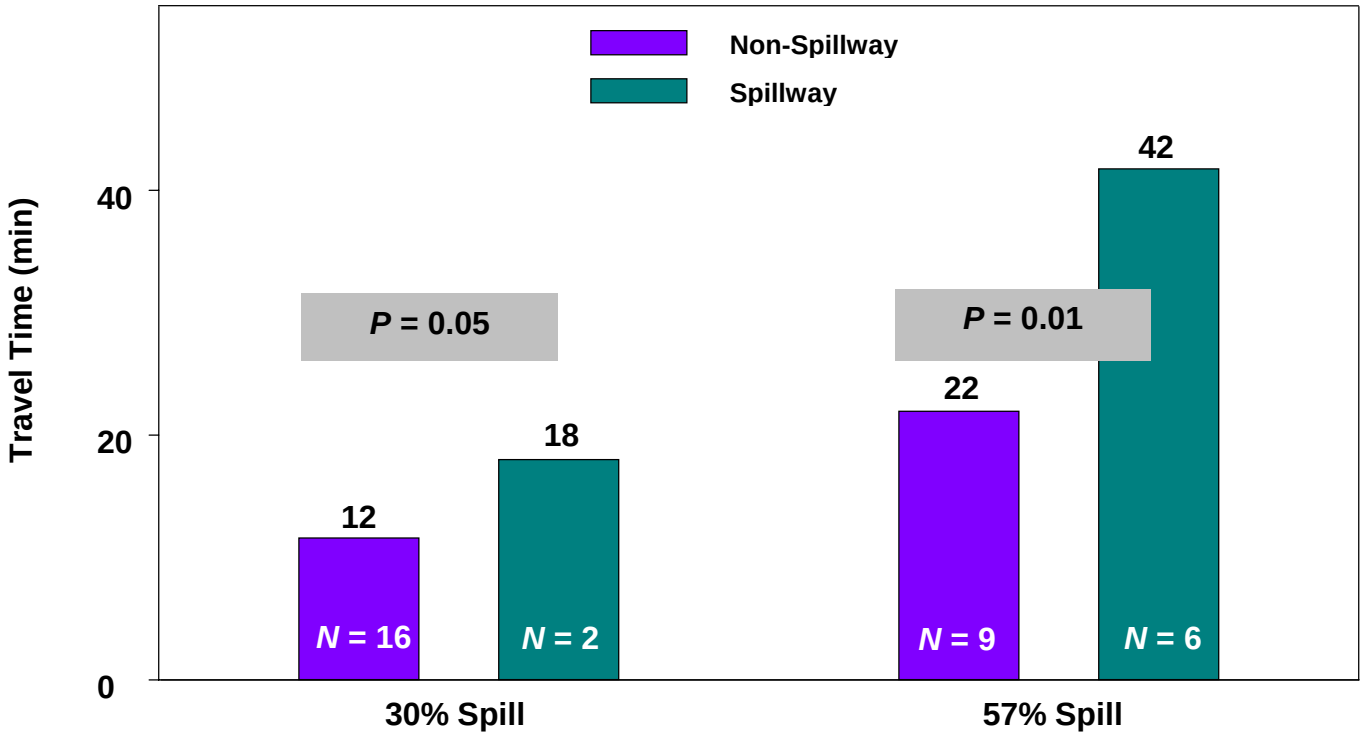

Figure 14. Median travel times of "spillway" zone and "non-spillway" zone wild juvenile steelhead during 30% and 57% night spill at John Day Dam, spring 2002. Travel times were measured from time of release through the juvenile bypass system to the time of the last detection at Exit 1. Sample sizes are shown in each bar. Each pair of bars was compared using a Kruskal-Wallis test and the *P*-value is presented for each pair. Actual values are shown on top of bars.

Volitionally-Passed Fish

Radio-tagged yearling Chinook salmon and juvenile steelhead released at Rock Creek for survival studies at JDA were also monitored for egress in the tailrace of JDA. These fish are referred to as "volitionally-passed fish" and represent the best surrogates for run-of-the-river fish. Fish were monitored for route of passage and egress through the tailrace. Actual dam operations during volitional passage of fish were 31%, 36%, and 53% during planned 30% day, 30% night, and 60% night spills.

Volitionally-Passed JBS Fish

Travel time from the JBS outfall to Exit 3 was determined for radio-tagged fish released at Rock Creek that passed JDA via the JBS. Median travel times to Exit 3 for yearling Chinook salmon were significantly different during 30% spill and 60% spill ($P = 0.001$). The median travel time during 30% spill was less than the median travel time during 60% spill (Table 7). Juvenile steelhead median travel time during 30% spill was less than the median travel time during 60% spill ($P = 0.003$; Table 7).

Table 7. Travel times (TT) of hatchery yearling Chinook salmon (CH1) and wild juvenile steelhead (STHD) released at Rock Creek that passed the juvenile bypass system at John Day Dam during 30% or 60% night spill conditions, spring 2002. Travel times were measured from time of passage through the juvenile bypass system outfall to a point 5.3 km downriver of the dam (Exit 3).

Species	Planned Spill (%)	TT from JBS passage to Exit 3 (min)		
		N	Median	Range
CH1	30	37	69.5	51.2 - 2395.0
CH1	60	37	89.6	49.9 - 245.7
STHD	30	11	57.4	27.1 - 80.2
STHD	60	18	86.9	46.7 - 105.0

Volitionally-Passed Spillway Fish

The fastest median travel time for volitionally passed yearling Chinook salmon occurred through the north half of the spillway during 60% night spill. The median travel time to Exit 3 during 60% night spill was significantly less than the median travel time during 30% day or 30% night spill for fish that passed through the north half of the spillway ($P < 0.001$; Table 8). Yearling Chinook salmon passing the south half of the spillway did not have significantly different median travel times for the three spill conditions ($P = 0.92$). Juvenile steelhead median travel times to Exit 3 for fish passing the north half or the south half of the spillway were not significantly different during 30% day, 30% night, and 60% night spill releases ($P = 0.31$ and $P = 0.88$ respectively). Regardless of spill condition, travel time was lowest for juvenile steelhead passing through the north end of the spillway (Table 8).

Table 8. Travel times (TT) of hatchery yearling Chinook salmon (CH1) and wild juvenile steelhead (STHD) released at Rock Creek that passed through John Day Dam under three planned spill conditions during the day (D) or night (N), spring 2002. Travel times were measured from time of passage through the north half of the spillway (NS) or the south half of the spillway (SS) to a point 5.3 km downriver of the dam (Exit 3).

Species	Planned Spill (%)	TT from NS passage to Exit 3 (min)			TT from SS passage to Exit 3 (min)		
		N	Median	Range	*N*	Median	Range
CH1	30D	33	68.6	48.1 - 172.6	38	64.9	8.6 - 164.2
CH1	30N	31	63.0	44.2 - 228.5	36	63.4	44.8 - 257.6
CH1	60N	43	53.3	7.5 - 84.1	80	65.7	43.7 - 153.4
STHD	30D	23	53.0	6.6 - 222.6	12	61.8	7.2 - 126.0
STHD	30N	24	54.1	37.1 - 141.7	21	60.1	38.0 - 107.2
STHD	60N	24	48.8	10.7 - 81.7	44	59.3	13.9 - 150.2

Fish that entered an eddy located along the exterior navigation lock wall were monitored for residence time within the eddy and predation during each of the spill regimes. Few of the radio-tagged fish detected in the tailrace were located in the eddy: 2.5% (18/727) of yearling Chinook salmon and 2.8% (8/285) of juvenile steelhead. The median eddy residence time of

both species during 30% night spill was greater than the median residence time during 30% day and 60% night spill (Table 9). Three predation events were documented for yearling Chinook salmon: two during 30% day spill, and one during 30% night spill. No predation events were documented for juvenile steelhead.

Table 9. Residence times (RT) of hatchery yearling Chinook salmon (CH1) and wild juvenile steelhead (STHD) released at Rock Creek and detected in the John Day Dam tailrace at an eddy site located along the exterior navigation lock wall, spring 2002. Fish passed under three planned spill conditions during the day (D) or night (N). Residence times were measured from time of first detection at the site to last detection.

Species	Planned Spill (%)	RT in Eddy (min)			# of Predation Events
		N	Median	Range	
CH1	30D	6	4.8	2.7 - 6.2	2
CH1	30N	5	16.5	3.6 - 42.4	1
CH1	60N	7	2.5	2.1 - 3.1	0
STHD	30D	2	2.5	2.4 - 2.5	0
STHD	30N	1	10.5	---	0
STHD	60N	5	3.5	2.1 - 12.8	0

Route of passage through the spillway was determined for fish detected at the eddy site. Of the 26 fish detected in the eddy, 65% passed through the north spillway (bays 1-9), and 35% had a southern passage route (bays 10-20). All confirmed predation events were for fish that passed through spillbay two. Spillbay passage routes by species and spill condition are depicted in Figure 15.

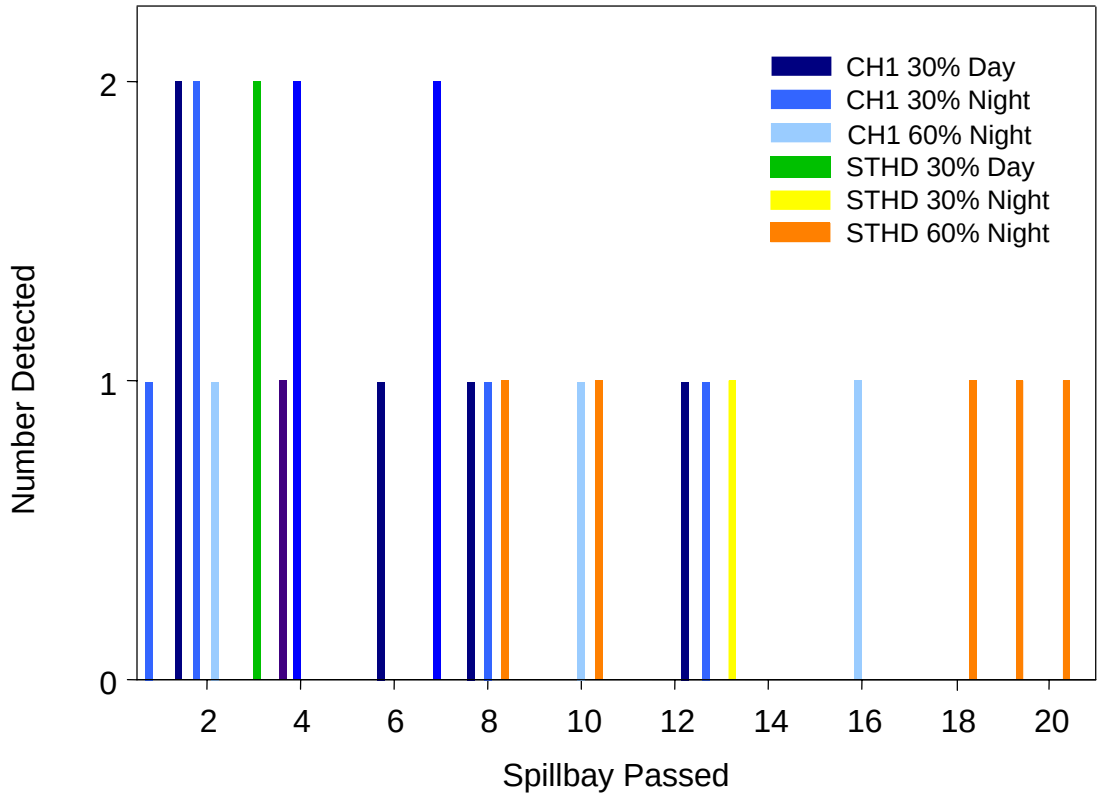

Figure 15. Spillbay passage routes of hatchery yearling Chinook (CH1) and wild juvenile steelhead (STHD) released at Rock Creek and detected at an eddy site located along the exterior navigation lock wall, spring 2002. Passage occurred during planned 30% day, 30% night, and 60% night spill.

SUBYEARLING FISH

Dam Operating Conditions

Dam operating conditions varied from planned conditions during the study period (Table 10). Total discharge during releases ranged from 200.3 to 313.7 kcfs with a mean of 253.3 kcfs (Table 10). During periods of proposed 30% spill, actual spill ranged from 30% to 38%, with a mean spill of 33%. Actual spill was 52% during periods of proposed 60% spill (Table 10). Tailrace elevation remained relatively constant during the study period (Table 10). Appendices 1, 2, and 3 depict hourly dam operations for all release dates. Due to inconsistent dam operations during the summer study period, two releases during 33% spill conditions and one release during 52% spill conditions were omitted from analysis.

Table 10. Dam operating conditions during the dates radio-tagged subyearling Chinook salmon were released at John Day Dam, summer 2002. The total discharge, spill discharge, and tailrace elevation are the mean hourly discharges for the period starting one hour before each release and continuing for eleven hours after each release. Data were collected from http://www.nwd-wc.usace.army.mil/tmt.

Planned % Spill	Release Date	Total Discharge (kcfs)	Spill kcfs (%)	Tailrace Elevation (ft)
30	7/01	291.5	111.1 (38.1)	162.0
30	7/13	267.3	78.7 (29.5)	162.3
30	7/17	251.8	76.1 (30.2)	161.7
30	**Mean**	270.2	88.6 (32.6)	162.0
60	6/29	313.7	150.2 (47.9)	162.6
60	7/09	201.2	114.3 (56.8)	160.1
60	7/11	247.3	118.4 (47.9)	161.4
60	7/15	200.3	106.8 (53.3)	160.0
60	**Mean**	240.6	122.4 (51.5)	161.0

Tagging and Release

A total of 65 radio-tagged hatchery subyearling Chinook salmon were released through the JBS between 29 June and 17 July 2002. Additional fish were released and monitored, but

were omitted from analysis due to periods of inconsistent dam operations. Each of our seven releases were conducted between approximately 1900 hours and 0100 hours. The summer study period coincided with the migration period of subyearling Chinook salmon (Figure 16). Mean fork lengths and weights are presented in Table 11. The radio tag represented 5.3% of mean fish body weight. Of the 65 subyearling Chinook salmon tagged, there were no regurgitated tags and no mortalities during the 24-h holding period.

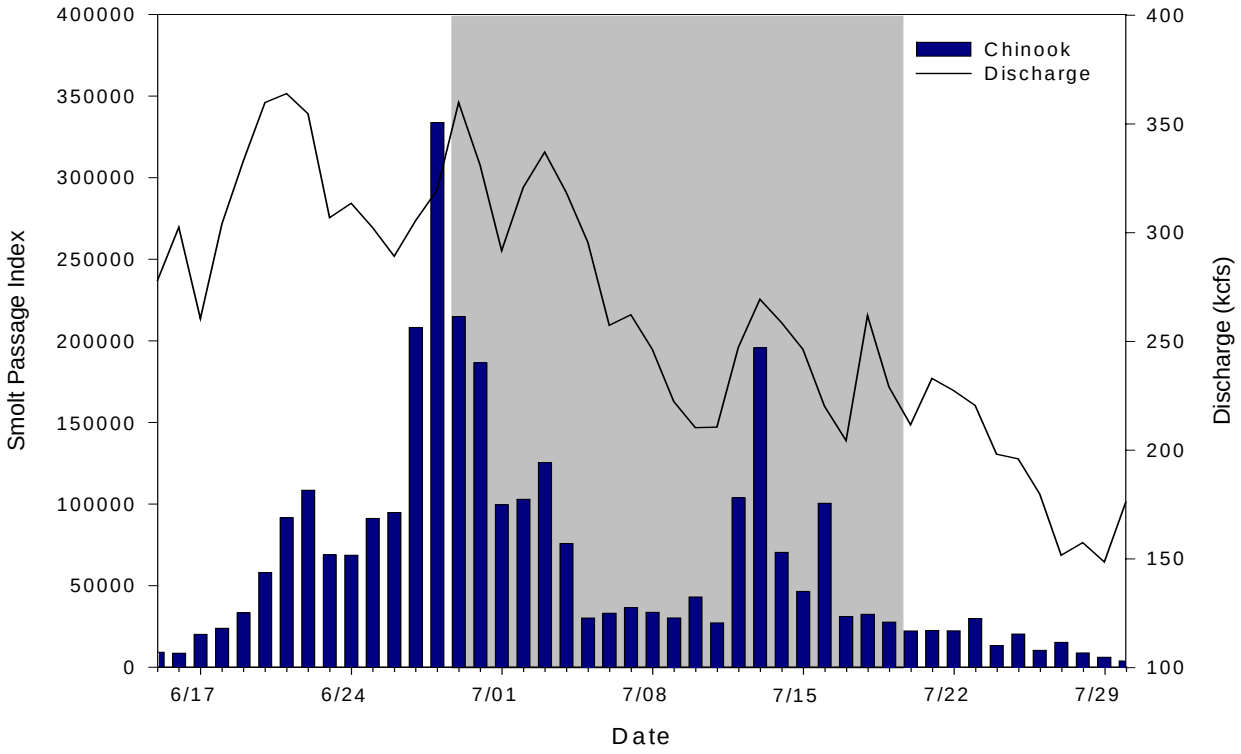

Figure 16. Smolt passage index for subyearling Chinook salmon at John Day Dam's smolt monitoring facility during summer 2002. Shaded area represents the study period. Discharge represents total river flow at John Day Dam. Smolt index data were acquired from the Fish Passage Center web page at http://www.fpc.org.

Table 11. Fork lengths and weights of subyearling Chinook salmon released through the juvenile bypass system during 33% and 52% spill at John Day Dam, summer 2002.

Release			Fork length (mm)		Weight (g)	
Date	Spill	*N*	Mean	Range	Mean	Range
07/01/02	33%	10	115	111 - 133	15.8	13.5 - 23.1
07/13/02	33%	10	117	112 - 134	18.4	16.3 - 24.3
07/17/02	33%	6	114	110 - 118	16.7	14.8 - 19.7
Overall	33%	26	116	110 - 134	17.0	13.5 - 24.3
06/29/02	52%	9	113	110 - 118	14.8	13.3 - 16.5
07/09/02	52%	10	116	110 - 128	17.1	14.3 - 22.3
07/11/02	52%	10	115	110 - 135	16.9	14.2 - 26.6
07/15/02	52%	10	121	110 - 136	19.8	14.7 - 28.0
Overall	52%	39	117	110 - 136	17.2	13.3 - 28.0
Total		**65**	**116**	**110 - 136**	**17.0**	**13.3 - 28.0**

Travel Time to Exit Stations

The median travel time to Exit 1 was significantly greater during 52% spill than during 33% spill (Table 12, Figure 17). Subyearling Chinook salmon reached Exit 1 in 10 min (median) during 33% spill, and took 15 min (median) during 52% spill conditions. Differences in median travel times to Exit 2 during 33% and 52% spill releases were significant (Figure 17), with a median travel time during 52% spill more than twice as long as the median travel time during 33% spill (Figure 17, Table 12). The numbers of fish used for this comparison, however, were low. Median travel times to Exit 3 were not significantly different during 33% and 52% spill releases (Table 12, Figure 17).

Table 12. Travel times (TT) of hatchery subyearling Chinook salmon during 33% spill and 52% spill at John Day Dam, summer 2002. All releases were conducted at night through the juvenile bypass system. Travel times were measured from time of release to the time of last detection at three fixed stations: the boat-restricted zone line located 0.7 km downriver of the dam (Exit 1), the dredge island located 1.9 km downriver of the dam (Exit 2), and a point 5.3 km downriver of the dam (Exit 3).

Spill (%)	Release date	Number released	TT from release to Exit 1 (min)			TT from release to Exit 2 (min)			TT from release to Exit 3 (min)		
			N	Median	Range	*N*	Median	Range	*N*	Median	Range
33	7/01	10	8	7.9	6.2 - 10.8	2	16.4	15.6 - 17.2	9	51.7	48.7 - 71.2
	7/13	10	5	11.3	8.5 - 32.4	1	20.5	20.5 - 20.5	10	58.3	49.4 - 73.9
	7/17	6	3	12.9	10.1 - 14.7	2	20.9	18.0 - 23.8	6	67.6	55.9 - 75.9
	Overall	26	16	9.6	6.2 - 32.4	5	18.0	15.6 - 23.8	25	58.2	48.7 - 75.9
52	6/29	9	6	9.0	8.2 - 14.4	2	16.9	15.2 - 18.6	7	52.8	22.9 - 61.7
	7/09	10	4	67.1	26.6 - 110.9	2	84.1	83.7 - 84.5	6	150.0	39.7 - 257.4
	7/11	10	6	13.7	9.4 - 15.9	2	26.3	21.5 - 31.2	9	58.9	51.1 - 97.2
	7/15	10	3	30.0	26.9 - 40.1	3	51.8	42.2 - 53.0	7	86.3	76.5 - 122.8
	Overall	39	19	14.9	8.2 - 110.9	9	42.2	15.2 - 84.5	29	62.2	22.9 - 257.4

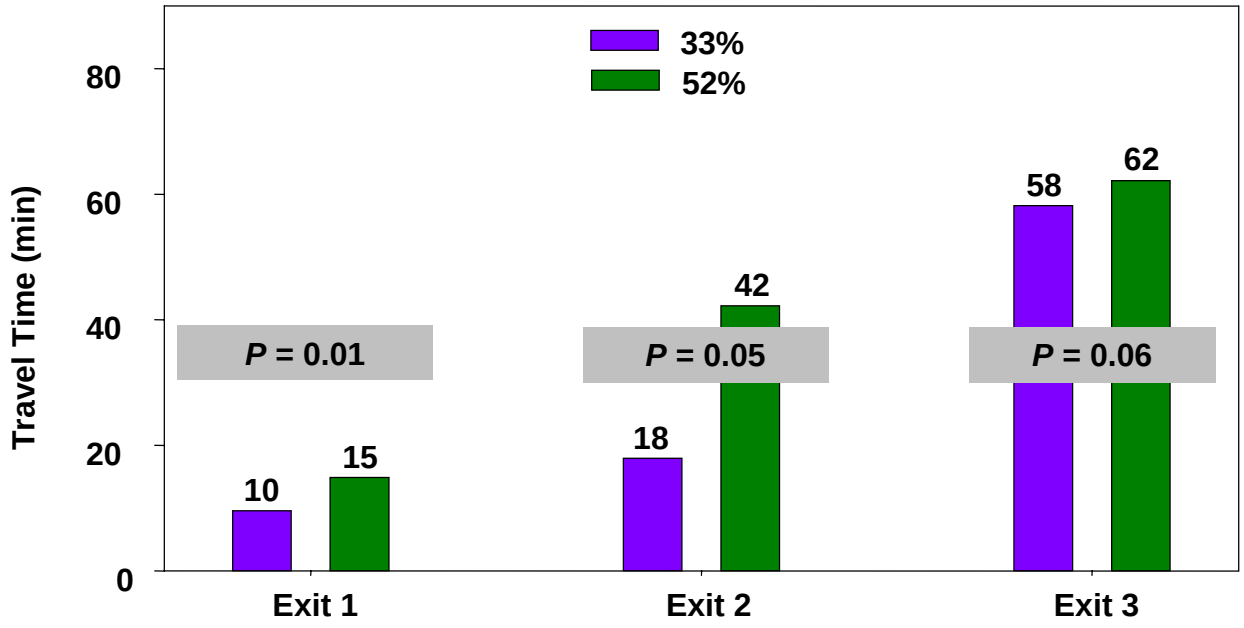

Figure 17. Median travel times of hatchery subyearling Chinook salmon during 33% and 52% night spill at John Day Dam, summer 2002. Travel times were measured from time of release through the juvenile bypass system to the time of the last detection at three stations: the boat-restricted zone line (Exit 1), the dredge island located 1.9 km downriver of the dam (Exit 2), and a point 5.3 km downriver of the dam (Exit 3). Sample sizes reflect those shown in Table 1. Each pair of bars was compared using a Kruskal-Wallis test and the P-value is presented for each pair. Actual values are shown on top of bars.

Travel Rates

Subyearling Chinook salmon released during 33% spill had higher travel rates to all three exits than during 52% spill (Table 13). The lowest travel rate for subyearling Chinook salmon was between the JBS outfall and Exit 1 during 52% spill. This was the lowest observed rate during either the spring or summer study periods.

Table 13. Travel rates (TR) for hatchery subyearling Chinook salmon during 33% and 52% spill at John Day Dam, summer 2002. All releases were conducted at night through the juvenile bypass system. Travel rates were calculated using detections from three fixed stations: the boat-restricted zone line located 0.7 km downriver of the dam (Exit 1), the dredge island located 1.9 km downriver of the dam (Exit 2), and a point 5.3 km downriver of the dam (Exit 3).

	TR from release to Exit 1 (km/h)			TR from Exit 1 to Exit 2 (km/h)			TR from Exit 2 to Exit 3 (km/h)		
% Spill	*N*	Median	Range	*N*	Median	Range	*N*	Median	Range
33	16	4.4	1.3 - 6.8	5	7.8	7.6 - 9.2	4	4.8	4.2 - 5.7
52	19	2.8	0.4 - 5.1	6	6.2	4.6 - 17.0	9	4.7	2.9 - 27.9

Travel Routes

Boat tracking was used to monitor individual fish movements within and downriver of the BRZ. During 33% spill, 231 fish locations were recorded representing 33 individual subyearling Chinook salmon (Figure 18). During 52% spill, subyearling Chinook salmon detections included 218 locations representing 33 individual fish (Figure 19). Locations were plotted on a map of the river to determine routes of travel for individual fish. Figure 20 depicts representative routes of travel of subyearling Chinook salmon that exhibited travel times ± 1 min of the median travel time during 33% spill conditions and fish that exhibited the closest documented travel times to the median travel time during 52% spill conditions. A typical travel route of a fish released through the JBS involved the fish making an arc initially toward the spillway outflow then toward the southern shoreline, following the contours of the shoreline as it

moved downriver. Routes of travel for all individual subyearling Chinook salmon tracked during each spill condition are presented in Appendix 4**.**

Dredge Island Passage

Spill condition did not influence subyearling Chinook salmon island passage route. Using fixed station data from Exit 2 and boat tracking, we were able to identify the general route of passage taken by radio-tagged fish as they passed the dredge island. All subyearling Chinook salmon released through the JBS passed the dredge island on the south side during both 33% and 52% spill conditions.

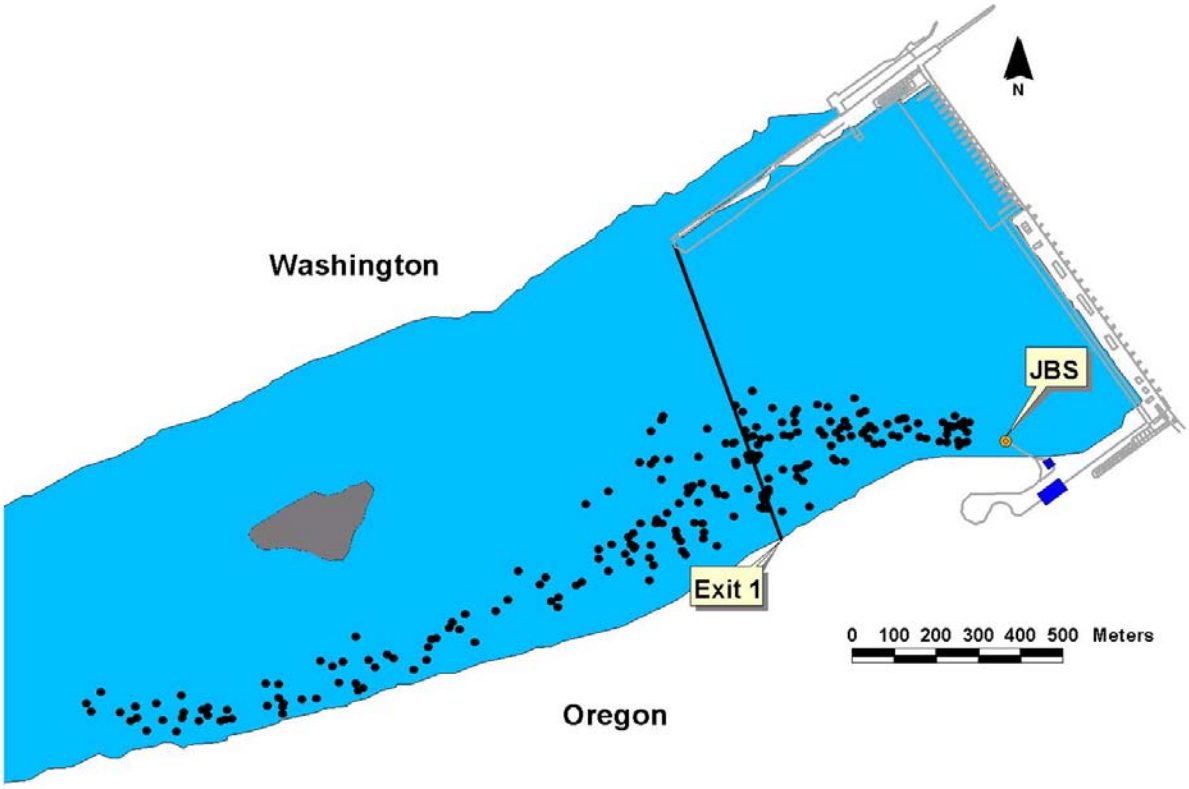

Figure 18. Locations of hatchery subyearling Chinook salmon released through the juvenile bypass system during 33% spill at John Day Dam, summer 2002. Each point represents a fish location collected via boat tracking. Chinook detections total 231 points, representing 33 individual fish.

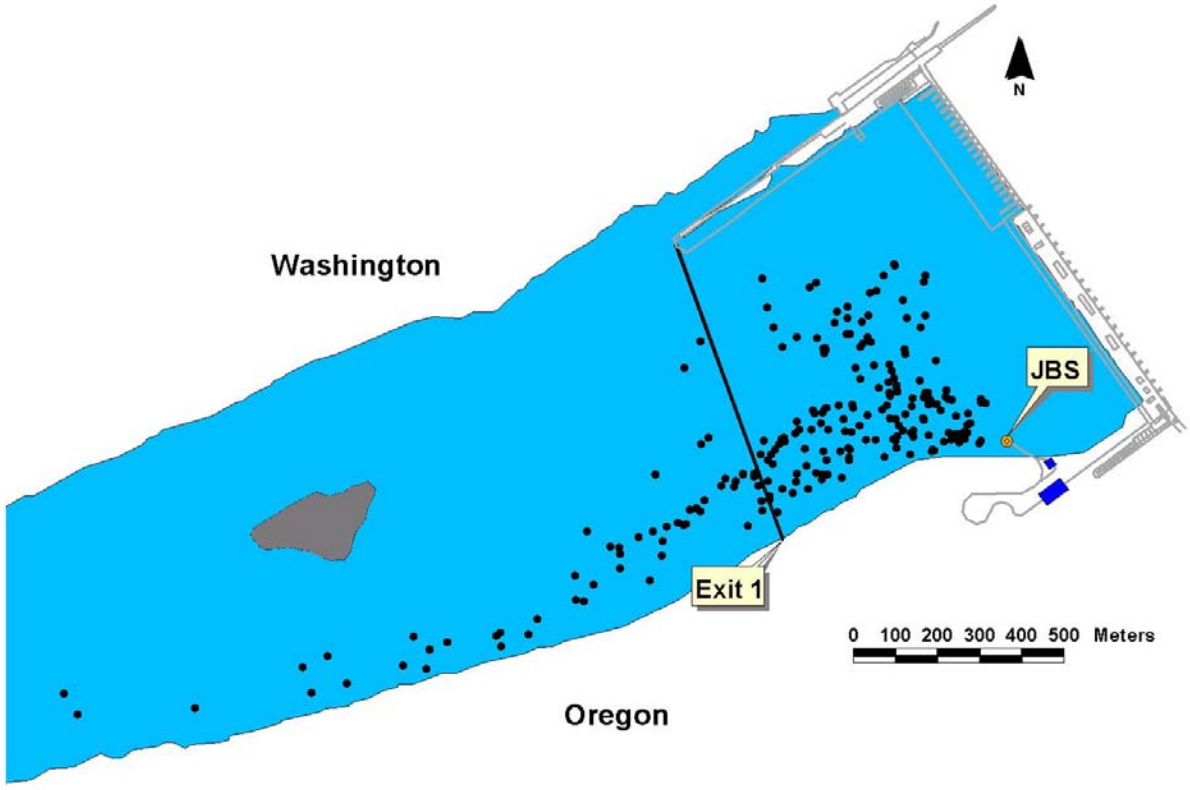

Figure 19. Locations of hatchery subyearling Chinook salmon released through the juvenile bypass system during 52% spill at John Day Dam, summer 2002. Each point represents a fish location collected via boat tracking. Chinook detections total 218 points, representing 33 individual fish.

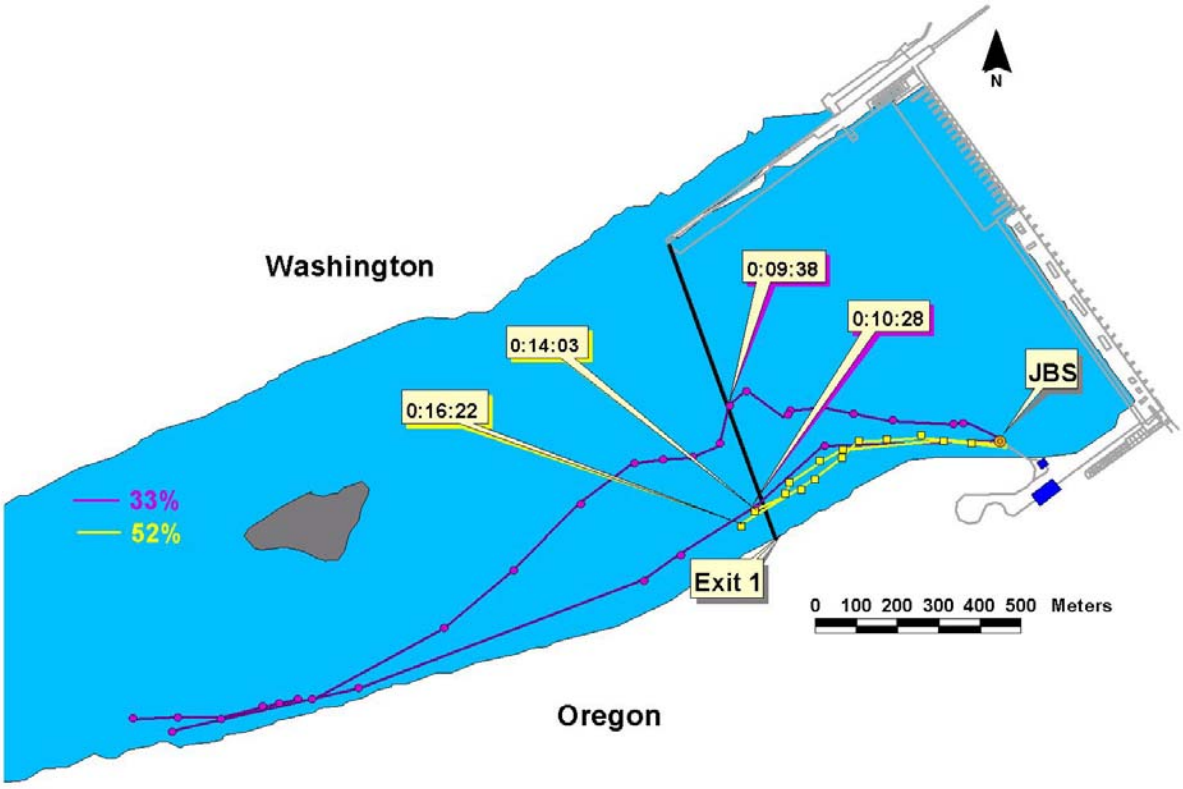

Figure 20. Representative travel routes of hatchery subyearling Chinook salmon released through the juvenile bypass system during 33% and 52% spill at John Day Dam, summer 2002. Times represent total travel time from release to Exit 1. The 33% spill fish exhibited travel times +/- 1 min of the median travel times in Table 1. The 52% spill fish exhibited the closest documented travel times to the median travel times in Table 1. Each point represents a fish location collected via boat tracking.

Atypical Travel Routes

Radio-tagged fish were detected on the south shore, upriver of the JBS, during both 33% and 52% spill. A fixed station monitored fish movements upriver of the JBS outfall because of the potential for fish to delay in this area. One subyearling Chinook salmon (4% of study fish) was detected within this area during 33% spill conditions, and 4 (10% of study fish) were detected during 52% spill (Table 14). The median residence times were 11 and 30 min, and influenced the total travel time in the tailrace. The fish that was detected at this site during 33% spill conditions had a 52% delay and fish detected during 52% spill conditions had a 30% delay in total travel time (Table 14).

Table 14. Detections of hatchery subyearling Chinook salmon that were detected upriver of the juvenile bypass system outfall during 33% and 52% night spill at John Day Dam, summer 2002. Median residence times (RT) were calculated from the time of first detection to the time of last detection at this site. Median RT/TT is reported as the percentage of the total travel time (TT) that a fish was detected upriver of the JBS, and was used as an indicator of delay. Total travel time was measured to Exit 3, a point 5.3 km downriver of the John Day Dam.

% Spill	Number Released	*N* (%) Detected	Median RT (min)	Median RT/TT (%)
33	26	1 (3.8%)	(30.1)	(51.8)
52	39	4 (10.3%)	11.3	29.9

Boat tracking efforts within the BRZ identified fish that had atypical travel routes upon exiting the JBS outfall. Some fish traveled on a northern heading and entered the spillway outflow (as defined by our spillway zone). During 33% spill conditions, 27% of fish ($N = 6$) with known travel paths were identified as spillway fish. During 52% spill conditions, 31% of fish with known travel paths ($N = 9$) were identified as spillway fish. Travel routes of spillway fish are depicted in Figure 21.

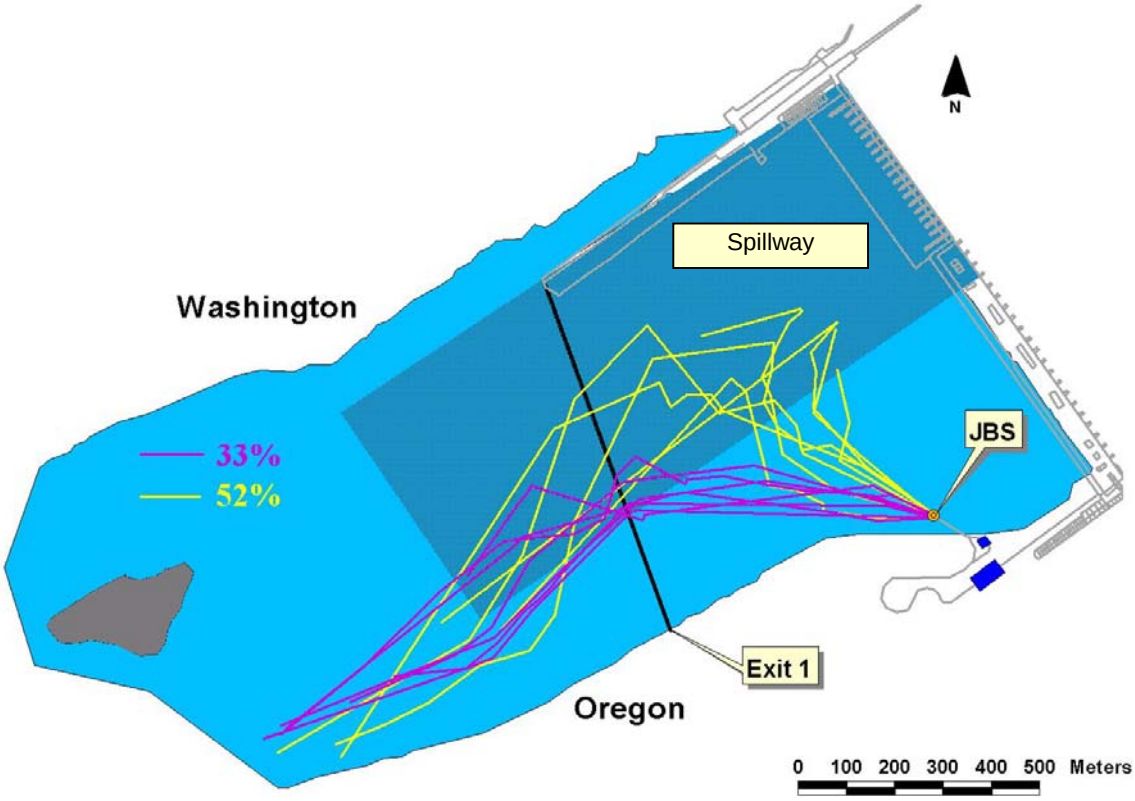

Figure 21. Travel routes of hatchery subyearling Chinook salmon released through the juvenile bypass system during 33% and 52% spill at John Day Dam, summer 2002. Each of these travel routes contained one or more documented locations within the spillway zone.

Fish that entered the spillway zone had longer travel times than fish that moved directly downriver following release, but were represented by a small sample size (N = 4). A larger number of fish were observed entering the spillway zone, but movement paths and exit times were incomplete due to safety issues of boat operation near the spillway. During 52% spill, the median travel time for spillway fish to Exit 1 (35.1 min) was over twice as long as the median travel time for non-spillway fish (14.4 min), but the difference was not significant (P = 0.06; Figure 22). Spillway and non-spillway fish displayed less of a difference in travel times during 33% spill conditions, with median travel times to Exit 1 of 12.7 min and 8.5 min (P = 0.20; Figure 22) respectively.

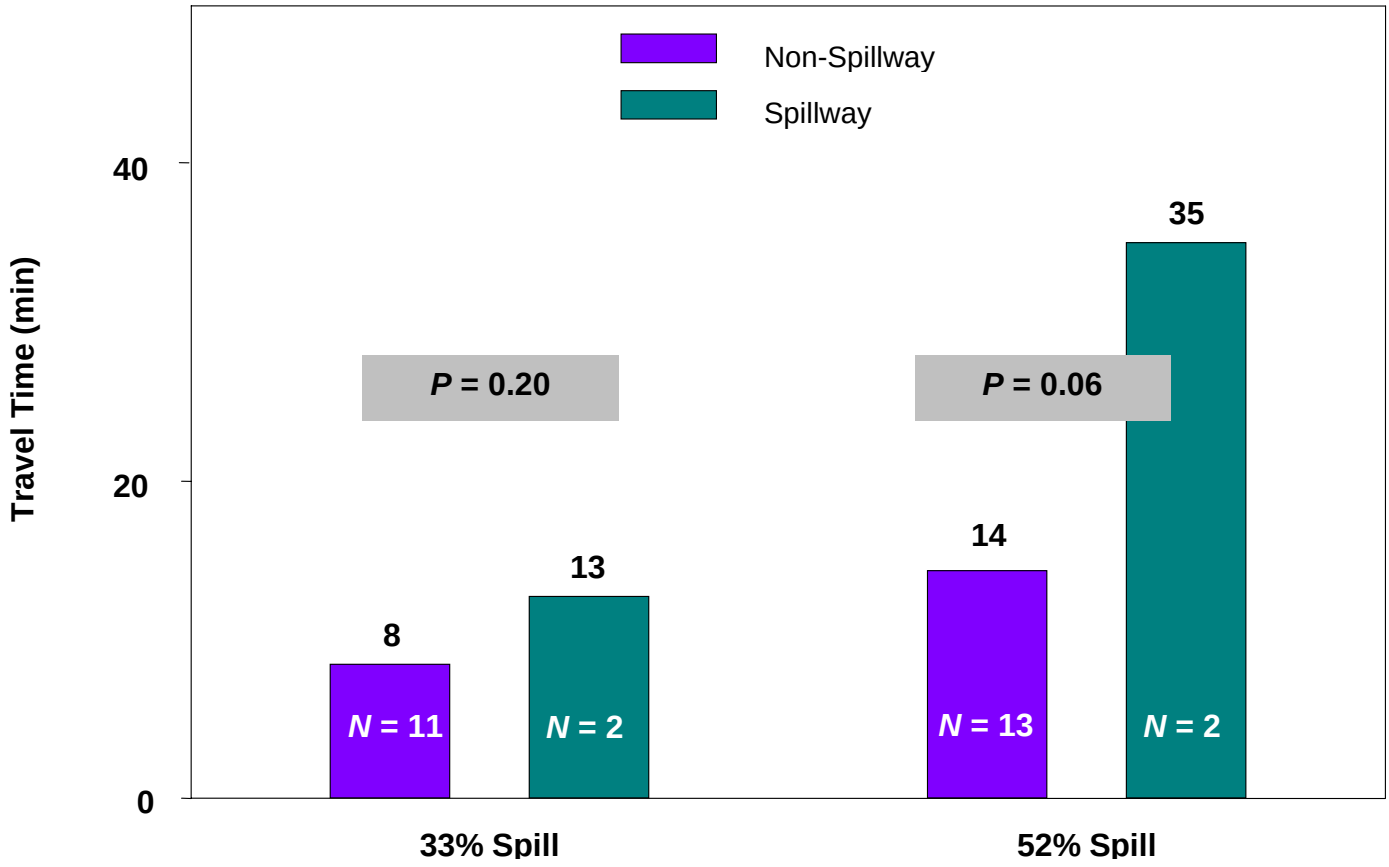

Figure 22. Median travel times of "spillway" zone and "non-spillway" zone hatchery subyearling Chinook salmon during 33% and 52% night spill at John Day Dam, summer 2002. Travel times were measured from time of release through the juvenile bypass system to the time of the last detection at Exit 1. Sample sizes are shown in each bar. Each pair of bars was compared using a Kruskal-Wallis test and the *P*-value is presented for each pair. Actual values are shown on top of bars.

Volitionally-Passed Fish

Radio-tagged subyearling Chinook salmon released at Rock Creek for survival studies at JDA were also monitored for egress in the tailrace of JDA. These fish are referred to as "volitionally-passed fish" and represent the best surrogates for run-of-the-river fish. Fish were monitored for route of passage and egress through the tailrace. Actual dam operations during volitional passage of fish were 29%, 30%, and 53% during planned 30% day, 30% night, and 60% night spills.

Volitionally-Passed JBS Fish

Travel time from the JBS outfall to Exit 3 was determined for radio-tagged fish released at Rock Creek that passed JDA via the JBS. Subyearling Chinook salmon median travel times to Exit 3 were not significantly different during 30% and 60% spill ($P = 0.11$; Table 15). Likewise, volitionally-passed JBS fish and fished released directly into the JBS had similar travel times to Exit 3.

Table 15. Travel times (TT) of hatchery subyearling Chinook salmon released at Rock Creek that passed through the juvenile bypass system at John Day Dam during 30% or 60% night spill conditions, summer 2002. Travel times were measured from time of passage through the juvenile bypass system outfall to a point 5.3 km downriver of the dam (Exit 3).

Planned Spill (%)	TT from JBS passage to Exit 3 (min)		
	N	Median	Range
30	12	63.3	56.7 - 400.1
60	7	65.6	61.2 - 94.5

Volitionally-Passed Spillway Fish

Median travel times for subyearling Chinook salmon passing the north or south half of the spillway were not significantly different during 30% day, 30% night, and 60% night spill ($P = 0.32$ and $P = 0.12$ respectively). Median travel times to Exit 3 were between 52 and 60 min during all spill conditions (Table 16).

Table 16. Travel times (TT) of hatchery subyearling Chinook salmon released at Rock Creek that passed through John Day Dam under three planned spill conditions during the day (D) or night (N), summer 2002. Travel times were measured from time of passage through the north half of the spillway (NS) or the south half of the spillway (SS) to a point 5.3 km downriver of the dam (Exit 3).

Planned Spill	TT from NS passage to Exit 3 (min)			TT from SS passage to Exit 3 (min)		
(%)	*N*	Median	Range	*N*	Median	Range
30D	23	55.9	41.1 - 149.6	18	59.5	37.6 - 89.7
30N	40	51.8	37.8 - 121.8	41	55.5	39.8 - 99.1
60N	33	56.2	34.6 - 193.6	71	51.9	16.2 - 127.7

Fish that entered an eddy located along the exterior navigation lock wall were monitored for residence time within the eddy and predation during each of the spill regimes. The incidence of radio-tagged fish detected in the eddy was low. Of the 1589 subyearling Chinook salmon detected in the tailrace, 7 (0.4%) were detected within the eddy. The residence times for the few subyearling Chinook salmon detected in the eddy were 6 – 9 min (Table 17). Four predation events were documented at this site during 60% night spill.

Table 17. Residence times (RT) of hatchery subyearling Chinook salmon released at Rock Creek and passing John Day Dam at an eddy site located along the exterior navigation lock wall, summer 2002. Fish passed under three planned spill conditions during the day (D) or night (N). Residence times were measured from time of first detection at the site to last detection.

Proposed Spill	RT in Eddy (min)			# of Predation
(%)	*N*	Median	Range	Events
30D	1	8.9	---	0
30N	1	5.5	---	0
60N	5	5.8	---	4

Route of passage through the spillway was determined for fish detected at the eddy site. No trend in spillbay passage route for subyearling Chinook salmon is evident (Figure 23), but no statistical comparisons were made due to low sample size ($N = 7$). Radio-tagged fish confirmed to

have been consumed by predators within the eddy passed the spillway through bays 9, 11, and 20 (Figure 23).

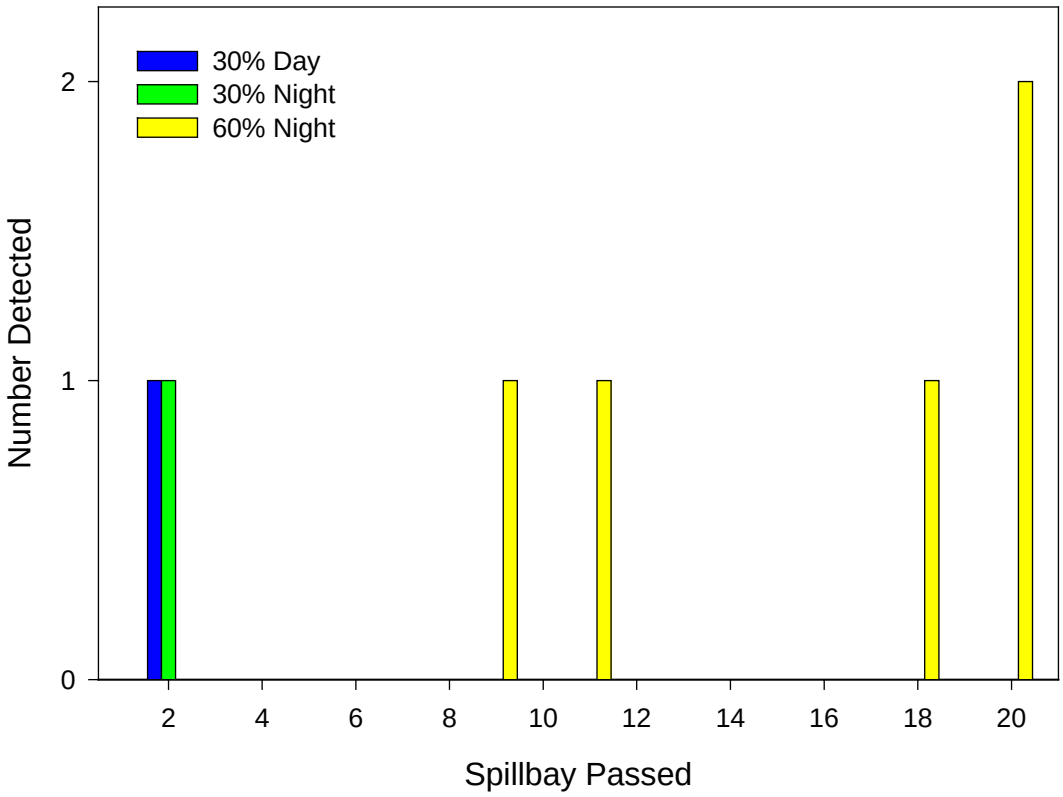

Figure 23. Spillbay passage routes of hatchery subyearling Chinook salmon released at Rock Creek and detected at an eddy site located along the exterior navigation lock wall, summer 2002. Passage occurred during planned 30% day, 30% night, and 60% night spill conditions.

DISCUSSION

The objective of this study was to describe the egress behavior of radio-tagged yearling and subyearling Chinook salmon and yearling steelhead released through the juvenile bypass system during different spill regimes. The study design involved either 0% during the day and 60% at night (12 - h spill) or 30% during the day and 30% at night (24 - h spill). The study was designed to make comparisons between the proposed 30% night and 60% night spill conditions. Actual spill during the spring was close to what was proposed, but variable dam operations during the summer caused a loss of some data.

Egress times of subyearling and yearling Chinook salmon and juvenile steelhead released through the JBS were longer during the high spill condition than during the low spill condition. The area of greatest delay for all species occurred between the JBS outfall and Exit 1. Yearling Chinook salmon and juvenile steelhead had median travel rates to Exit 1 that were two times slower during high spill conditions. The differences in travel rates for subyearling Chinook salmon were only slightly less. Differences in both travel times and travel rates became less significant with increasing distance from the outfall, suggesting that the effects of spill condition were localized to the immediate tailrace.

The extra time needed for fish to exit the tailrace during high spill conditions can affect their survival. The dangers to fish in this zone include exposure to predators and turbulence. The predators, being limited by their ability to hold station in high velocities, tend to congregate in the eddy along the navigation lock wall and on the south shoreline, above and below the bypass outfall (T. Liedtke, USGS, unpublished data). These areas were monitored during our study period, and a low incidence of predation events was documented. The turbulence, inherent

in a tailrace environment, may stress or disorient fish and could therefore affect predator avoidance ability.

The extended travel times of fish released during high spill conditions were due to indirect egress paths and specific areas of delay. Following JBS passage, fish with a direct egress path followed the contours of the south shoreline. The direct route was the dominant route during low spill conditions and resulted in short travel times (about 10 minutes). During high spill conditions, fish were more likely to have an indirect egress route, moving on a northern heading and entering the spillway outflow. Fish that entered the spillway outflow remained within the BRZ two times longer than fish that traveled immediately downriver following JBS passage. In addition to indirect egress paths, some areas of the BRZ can be sources of delay during high spill conditions. Duran et al. (2002) identified an area of delay upriver of the JBS outfall, near the south shore. Throughout our study period, a single fish was detected in this area during low spill, and 18 fish (7% of study fish) were detected during high spill conditions. The residence time within this area influenced the total travel time in the tailrace. Delay at this site during high spill conditions ranged from 5% for yearling Chinook salmon to 30% for subyearling Chinook salmon.

Patterns observed in fish that volitionally passed through the JBS support the study findings. Median travel times to Exit 3 were significantly higher during high spill for both yearling Chinook salmon and juvenile steelhead. For subyearling Chinook salmon, the median travel time was higher during high spill, although not significant. These trends followed those of fish that were released into the JBS, indicating no effects of a direct release.

Fish that passed through the spillway had better egress conditions than fish that passed through the JBS. Only minor changes in egress could be attributed to spill conditions. One risk

to spillway fish was delay or predation in an eddy on the navigation lock wall. Fish were detected in the eddy during all three spill regimes, but incidence was low (<2%). Residence time in the eddy was longest during proposed 30% night spill. Although few fish were detected in the eddy, the risk of predation was high (21%) for the fish that did enter the eddy.

In conclusion, fish passing through the JBS during high spill conditions experienced poor egress conditions. During high spill, the spillway passage route provides a small advantage in egress conditions as compared to low spill conditions. Considering that high spill conditions are generally seen as the best configuration to improve overall fish passage and survival, managers should continue to investigate options to improve egress conditions for fish passing JDA through the JBS during high spill conditions.

ACKNOWLEDGEMENTS

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Appendix 1. Summary of main unit (MU) and spillway dam operations at John Day Dam during 2002 fish releases.

Release Date	Hour	Spill %	Spill (kcfs)	Mean Spill (kcfs)	Total Flow	Mean Flow (kcfs)	Total MU (kcfs)	Mean MU (kcfs)
5/1/2002	1900	60	85.3		201.4		112.5	
5/1/2002	2000	60	85.3		200.7		113.0	
5/1/2002	2100	60	85.3		202.7		115.9	
5/1/2002	2200	60	85.3		223.9		138.0	
5/1/2002	2300	60	85.3		225.0		139.5	
5/2/2002	0000	60	85.3	85.3	227.1	241.4	140.1	154.4
5/2/2002	0100	60	85.3		248.1		159.5	
5/2/2002	0200	60	85.3		261.3		170.7	
5/2/2002	0300	60	85.3		261.4		179.3	
5/2/2002	0400	60	85.3		270.6		183.6	
5/2/2002	0500	60	85.3		275.9		189.9	
5/2/2002	0600	60	85.3		298.7		211.0	
5/5/2002	1900	60	149.3		267.6		112.9	
5/5/2002	2000	60	149.3		268.8		117.6	
5/5/2002	2100	60	149.6		278.6		126.6	
5/5/2002	2200	60	150.3		273.2		123.7	
5/5/2002	2300	60	150.3		242.4		97.9	
5/6/2002	0000	60	124.8	140.8	207.5	242.6	79.9	101.6
5/6/2002	0100	60	124.8		211.3		85.7	
5/6/2002	0200	60	135.2		226.7		92.8	
5/6/2002	0300	60	135.0		228.3		92.2	
5/6/2002	0400	60	135.1		228.8		92.8	
5/6/2002	0500	60	135.1		231.3		92.6	
5/6/2002	0600	60	150.5		246.3		103.9	
5/7/2002	1900	60	140.4		241.4		95.5	
5/7/2002	2000	60	140.4		239.3		96.6	
5/7/2002	2100	60	149.9		274.3		124.1	
5/7/2002	2200	60	150.3		270.2		117.4	
5/7/2002	2300	60	150.3		266.1		114.7	
5/8/2002	0000	60	150.3	142.5	257.9	244.5	106.8	100.5
5/8/2002	0100	60	150.3		253.4		105.9	
5/8/2002	0200	60	135.5		228.4		90.4	
5/8/2002	0300	60	135.5		226.0		88.4	
5/8/2002	0400	60	135.5		227.3		88.2	
5/8/2002	0500	60	135.5		226.8		89.7	
5/8/2002	0600	60	135.5		223.0		88.4	
5/9/2002	1900	30	60.3		200.6		139.0	
5/9/2002	2000	30	60.2		204.1		141.6	
5/9/2002	2100	30	59.6		204.4		142.0	

Release Date	Hour	Spill %	Spill (kcfs)	Mean Spill (kcfs)	Total Flow	Mean Flow (kcfs)	Total MU (kcfs)	Mean MU (kcfs)
5/9/2002	2200	30	60.4		205.8		141.8	
5/9/2002	2300	30	60.4		202.1		140.5	
5/10/2002	0000	30	60.4	60.7	198.8	201.6	138.2	139.4
5/10/2002	0100	30	60.4		196.8		133.6	
5/10/2002	0200	30	60.4		192.7		134.7	
5/10/2002	0300	30	60.4		197.6		136.5	
5/10/2002	0400	30	60.4		199.3		138.2	
5/10/2002	0500	30	60.4		202.1		139.1	
5/10/2002	0600	30	65.1		214.7		147.0	
5/11/2002	1900	30	42.3		140.4		97.4	
5/11/2002	2000	30	47.2		153.6		92.4	
5/11/2002	2100	30	53.7		177.8		122.9	
5/11/2002	2200	30	53.8		170.6		115.3	
5/11/2002	2300	30	51.5		165.0		112.6	
5/12/2002	0000	30	47.1	49.3	151.0	161.8	103.2	109.2
5/12/2002	0100	30	47.1		153.9		104.1	
5/12/2002	0200	30	47.0		153.7		104.4	
5/12/2002	0300	30	47.0		154.9		104.2	
5/12/2002	0400	30	47.1		155.4		105.2	
5/12/2002	0500	30	51.1		170.4		117.3	
5/12/2002	0600	30	57.0		194.5		131.7	
5/13/2002	1900	60	138.8		238.9		93.7	
5/13/2002	2000	60	138.8		221.1		81.3	
5/13/2002	2100	60	138.6		233.1		93.1	
5/13/2002	2200	60	138.6		229.2		90.4	
5/13/2002	2300	60	114.3		188.5		71.7	
5/14/2002	0000	60	114.3	121.5	186.2	200.2	72.5	79.0
5/14/2002	0100	60	114.3		177.1		72.8	
5/14/2002	0200	60	105.0		175.5		68.3	
5/14/2002	0300	60	105.0		175.8		69.3	
5/14/2002	0400	60	105.0		178.0		70.5	
5/14/2002	0500	60	115.3		192.7		78.1	
5/14/2002	0600	60	130.2		206.2		86.2	
5/15/2002	1900	60	131.8		228.0		89.9	
5/15/2002	2000	60	131.8		224.3		89.0	
5/15/2002	2100	60	144.2		244.0		96.2	
5/15/2002	2200	60	144.6		240.3		95.5	
5/15/2002	2300	60	144.6		239.3		94.3	
5/16/2002	0000	60	144.6	135.1	243.0	226.4	97.4	91.1
5/16/2002	0100	60	144.6		241.1		100.1	
5/16/2002	0200	60	131.9		221.0		88.3	
5/16/2002	0300	60	125.9		209.4		85.3	
5/16/2002	0400	60	125.9		213.3		86.1	

Release Date	Hour	Spill %	Spill (kcfs)	Mean Spill (kcfs)	Total Flow	Mean Flow (kcfs)	Total MU (kcfs)	Mean MU (kcfs)
5/16/2002	0500	60	125.9		213.3		85.8	
5/16/2002	0600	60	125.9		199.6		85.6	
5/17/2002	1900	30	58.1		192.0		134.6	
5/17/2002	2000	30	58.1		199.5		137.9	
5/17/2002	2100	30	64.1		216.2		151.1	
5/17/2002	2200	30	64.2		217.4		153.0	
5/17/2002	2300	30	64.2		213.3		147.0	
5/18/2002	0000	30	64.2	65.2	215.8	219.3	151.6	152.5
5/18/2002	0100	30	64.2		218.8		151.2	
5/18/2002	0200	30	69.1		233.1		161.3	
5/18/2002	0300	30	69.1		227.6		157.7	
5/18/2002	0400	30	69.1		231.2		162.7	
5/18/2002	0500	30	69.1		233.2		160.0	
5/18/2002	0600	30	69.1		233.0		162.4	
5/19/2002	1900	30	72.1		244.2		169.6	
5/19/2002	2000	30	75.0		254.0		180.1	
5/19/2002	2100	30	74.9		256.5		177.2	
5/19/2002	2200	30	84.6		288.0		203.1	
5/19/2002	2300	30	80.9		271.1		187.8	
5/20/2002	0000	30	80.3	75.2	253.9	253.7	171.6	177.3
5/20/2002	0100	30	72.5		247.5		173.7	
5/20/2002	0200	30	72.5		248.4		176.3	
5/20/2002	0300	30	72.5		245.3		171.7	
5/20/2002	0400	30	72.5		245.0		172.1	
5/20/2002	0500	30	72.5		240.8		171.1	
5/20/2002	0600	30	72.5		249.1		173.3	
5/21/2002	1900	60	155.7		269.1		104.2	
5/21/2002	2000	60	155.2		281.1		124.1	
5/21/2002	2100	60	155.2		300.5		144.6	
5/21/2002	2200	60	155.7		299.6		140.9	
5/21/2002	2300	60	155.7		296.3		140.9	
5/22/2002	0000	60	155.7	150.4	275.9	279.4	118.0	121.9
5/22/2002	0100	60	155.7		273.4		117.9	
5/22/2002	0200	60	155.7		278.1		121.9	
5/22/2002	0300	60	155.7		277.6		122.5	
5/22/2002	0400	60	92.4		256.3		106.8	
5/22/2002	0500	60	155.7		271.3		108.9	
5/22/2002	0600	60	155.8		273.4		112.6	
5/23/2002	1900	60	155.1		300.3		137.3	
5/23/2002	2000	60	155.3		292.1		135.6	
5/23/2002	2100	60	155.3		294.6		134.4	
5/23/2002	2200	60	155.8		294.5		136.8	
5/23/2002	2300	60	156.2		289.9		133.5	

Release Date	Hour	Spill %	Spill (kcfs)	Mean Spill (kcfs)	Total Flow	Mean Flow (kcfs)	Total MU (kcfs)	Mean MU (kcfs)
5/24/2002	0000	60	156.6	154.4	275.7	275.6	119.8	119.4
5/24/2002	0100	60	156.7		260.0		96.9	
5/24/2002	0200	60	150.2		250.8		100.9	
5/24/2002	0300	60	150.3		252.3		101.0	
5/24/2002	0400	60	150.3		257.8		103.6	
5/24/2002	0500	60	155.8		266.3		110.5	
5/24/2002	0600	60	155.8		272.8		122.8	
5/25/2002	1900	30	66.0		221.4		150.8	
5/25/2002	2000	30	65.8		218.6		151.4	
5/25/2002	2100	30	65.9		221.7		154.4	
5/25/2002	2200	30	65.8		225.1		158.7	
5/25/2002	2300	30	62.8		212.6		146.4	
5/26/2002	0000	30	62.8	63.8	212.1	215.0	146.0	149.2
5/26/2002	0100	30	62.8		210.7		147.3	
5/26/2002	0200	30	62.8		210.9		147.7	
5/26/2002	0300	30	62.8		211.0		147.8	
5/26/2002	0400	30	62.9		211.5		147.5	
5/26/2002	0500	30	62.9		210.6		146.0	
5/26/2002	0600	30	62.9		213.5		146.1	
5/27/2002	1900	30	85.6		262.7		185.1	
5/27/2002	2000	30	82.6		261.6		186.4	
5/27/2002	2100	30	82.6		261.6		183.1	
5/27/2002	2200	30	82.6		256.6		181.8	
5/27/2002	2300	30	75.7		254.3		178.8	
5/28/2002	0000	30	75.7	81.3	255.7	277.7	180.9	197.9
5/28/2002	0100	30	75.5		264.9		193.3	
5/28/2002	0200	30	83.1		272.1		185.2	
5/28/2002	0300	30	83.1		304.8		220.4	
5/28/2002	0400	30	83.1		310.3		228.0	
5/28/2002	0500	30	83.1		315.2		232.2	
5/28/2002	0600	30	83.1		312.7		220.0	
5/29/2002	1900	60	154.8		386.7		229.6	
5/29/2002	2000	60	154.9		325.1		164.4	
5/29/2002	2100	60	154.9		333.6		177.5	
5/29/2002	2200	60	154.7		332.3		177.3	
5/29/2002	2300	60	154.9		295.6		139.2	
5/30/2002	0000	60	155.2	155.1	261.2	294.9	101.1	138.8
5/30/2002	0100	60	155.2		262.2		107.8	
5/30/2002	0200	60	155.2		263.1		105.7	
5/30/2002	0300	60	155.4		262.8		106.2	
5/30/2002	0400	60	155.5		263.0		106.6	
5/30/2002	0500	60	155.5		265.3		106.9	
5/30/2002	0600	60	155.5		288.0		143.5	

Release Date	Hour	Spill %	Spill (kcfs)	Mean Spill (kcfs)	Total Flow	Mean Flow (kcfs)	Total MU (kcfs)	Mean MU (kcfs)
6/29/2002	1900	60	150.9		343.4		184.8	
6/29/2002	2000	60	151.0		336.4		184.6	
6/29/2002	2100	60	151.0		336.1		179.8	
6/29/2002	2200	60	151.0		331.7		179.8	
6/29/2002	2300	60	151.0		332.8		179.8	
6/29/2002	0000	60	151.0	138.4	330.1	313.7	150.2	168.2
6/30/2002	0100	60	151.0		308.5		138.1	
6/30/2002	0200	60	151.0		292.1		136.8	
6/30/2002	0300	60	151.0		288.7		137.1	
6/30/2002	0400	60	151.0		288.0		135.8	
6/30/2002	0500	60	151.0		287.8		135.9	
6/30/2002	0600	60	0.0		289.0		275.7	
7/1/2002	1900	30	89.3		309.1		218.4	
7/1/2002	2000	30	87.5		314.3		235.2	
7/1/2002	2100	30	87.5		325.7		234.1	
7/1/2002	2200	30	87.5		324.6		225.3	
7/1/2002	2300	30	87.5		316.2		185.6	
7/2/2002	0000	30	87.5	112.1	279.5	291.5	192.6	173.4
7/2/2002	0100	30	87.5		280.4		169.3	
7/2/2002	0200	30	87.5		262.1		177.2	
7/2/2002	0300	30	184.7		263.1		87.2	
7/2/2002	0400	30	184.5		276.8		87.4	
7/2/2002	0500	30	184.5		274.9		86.2	
7/2/2002	0600	30	89.7		271.2		181.8	
7/9/2002	1900	60	149.3		283.0		148.8	
7/9/2002	2000	60	148.8		299.0		121.8	
7/9/2002	2100	60	138.4		272.6		97.7	
7/9/2002	2200	60	108.6		232.5		63.9	
7/9/2002	2300	60	108.6		177.7		64.6	
7/10/2002	0000	60	108.6	104.2	175.0	201.2	70.6	85.5
7/10/2002	0100	60	108.2		182.0		69.9	
7/10/2002	0200	60	89.9		176.5		63.4	
7/10/2002	0300	60	90.0		155.0		63.3	
7/10/2002	0400	60	90.0		153.6		64.2	
7/10/2002	0500	60	90.0		154.0		61.2	
7/10/2002	0600	60	20.4		153.2		136.8	
7/11/2002	1900	60	159.3		294.6		166.5	
7/11/2002	2000	60	159.2		325.9		168.2	
7/11/2002	2100	60	159.2		328.2		166.4	
7/11/2002	2200	60	159.0		329.2		188.8	
7/11/2002	2300	60	159.2		343.9		128.8	
7/12/2002	0000	60	145.2	119.7	288.5	247.3	91.4	118.4
7/12/2002	0100	60	120.3		235.8		72.7	

Release Date	Hour	Spill %	Spill (kcfs)	Mean Spill (kcfs)	Total Flow	Mean Flow (kcfs)	Total MU (kcfs)	Mean MU (kcfs)
7/12/2002	0200	60	93.9		192.2		59.8	
7/12/2002	0300	60	93.9		155.2		60.6	
7/12/2002	0400	60	93.9		156.0		62.4	
7/12/2002	0500	60	93.9		157.5		65.6	
7/12/2002	0600	60	0.0		161.1		189.1	
7/13/2002	1900	30	90.0		325.1		214.9	
7/13/2002	2000	30	90.0		307.9		210.4	
7/13/2002	2100	30	90.0		302.8		221.2	
7/13/2002	2200	30	81.1		306.4		185.0	
7/13/2002	2300	30	81.0		273.2		188.9	
7/14/2002	0000	30	81.0	76.3	272.2	267.3	191.2	178.7
7/14/2002	0100	30	75.1		271.3		172.4	
7/14/2002	0200	30	70.6		252.3		164.2	
7/14/2002	0300	30	70.9		235.9		164.8	
7/14/2002	0400	30	64.6		235.0		151.9	
7/14/2002	0500	30	64.6		217.1		147.7	
7/14/2002	0600	30	57.1		208.3		131.3	
7/15/2002	1900	60	144.4		204.7		97.4	
7/15/2002	2000	60	155.0		250.4		111.4	
7/15/2002	2100	60	154.9		262.2		117.9	
7/15/2002	2200	60	137.4		265.2		107.6	
7/15/2002	2300	60	119.8		240.2		78.0	
7/16/2002	0000	60	108.7	109.8	199.1	200.3	72.7	87.7
7/16/2002	0100	60	95.3		180.6		60.6	
7/16/2002	0200	60	95.3		157.2		64.2	
7/16/2002	0300	60	95.2		159.5		62.7	
7/16/2002	0400	60	95.3		160.4		62.9	
7/16/2002	0500	60	95.5		162.3		68.7	
7/16/2002	0600	60	20.4		161.8		148.1	
7/17/2002	1900	30	80.0		265.1		183.4	
7/17/2002	2000	30	80.0		273.5		191.8	
7/17/2002	2100	30	80.0		277.4		196.0	
7/17/2002	2200	30	87.0		277.0		194.6	
7/17/2002	2300	30	87.0		286.6		197.4	
7/18/2002	0000	30	70.0	75.3	288.1	251.8	203.0	174.6
7/18/2002	0100	30	70.0		230.9		158.4	
7/18/2002	0200	30	70.0		222.1		151.2	
7/18/2002	0300	30	70.0		222.3		152.4	
7/18/2002	0400	30	70.0		225.4		154.8	
7/18/2002	0500	30	70.0		225.3		154.8	
7/18/2002	0600	30	70.0		227.8		157.2	

Appendix 2. Main unit (MU) dam operations at John Day Dam during 2002 fish releases.

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
5/1/2002	1900	60	13.6	0.0	13.6	14.0	15.0	0.0	0.0	0.0	0.0	13.9	0.0	14.0	0.0	14.2	14.2	0.0
5/1/2002	2000	60	13.6	0.0	14.0	14.2	15.0	0.0	0.0	0.0	0.0	14.1	0.0	14.0	0.0	14.4	13.7	0.0
5/1/2002	2100	60	13.4	0.0	14.3	15.0	14.4	0.0	0.0	0.0	0.0	14.9	0.0	14.8	0.0	15.2	13.9	0.0
5/1/2002	2200	60	13.8	0.0	17.9	17.2	17.1	0.0	0.0	0.0	0.0	18.1	0.0	17.6	0.0	18.6	17.7	0.0
5/1/2002	2300	60	15.7	0.0	14.7	15.8	15.2	0.0	0.0	0.0	0.0	15.4	15.8	15.7	0.0	15.7	15.5	0.0
5/2/2002	0000	60	15.7	0.0	15.1	15.7	15.1	0.0	0.0	0.0	0.0	15.5	15.9	15.4	0.0	15.9	15.8	0.0
5/2/2002	0100	60	15.9	0.0	15.8	15.9	16.5	0.0	0.0	0.0	15.9	15.7	16.1	16.4	0.0	15.7	15.6	0.0
5/2/2002	0200	60	17.3	0.0	16.4	17.4	17.1	0.0	0.0	0.0	17.5	16.5	17.3	17.3	0.0	17.5	16.4	0.0
5/2/2002	0300	60	16.6	0.0	15.7	16.3	16.9	0.0	0.0	0.0	16.4	16.4	16.5	15.9	0.0	16.0	16.5	16.1
5/2/2002	0400	60	16.9	0.0	16.4	16.9	16.6	0.0	0.0	0.0	16.8	16.5	16.8	16.3	0.0	16.9	16.4	17.1
5/2/2002	0500	60	15.1	14.7	14.0	14.2	14.6	14.7	0.0	0.0	14.8	14.8	15.1	14.4	0.0	14.6	14.3	14.6
5/2/2002	0600	60	15.3	15.8	16.0	16.3	16.3	16.2	0.0	0.0	16.3	16.2	16.8	16.6	0.0	16.3	16.2	16.7
5/5/2002	1900	60	13.0	0.0	12.2	12.6	12.6	0.0	0.0	12.3	0.0	12.2	12.5	0.0	0.0	13.0	12.5	0.0
5/5/2002	2000	60	13.1	0.0	12.6	13.2	12.7	0.0	0.0	13.2	0.0	13.2	13.6	0.0	0.0	13.3	12.7	0.0
5/5/2002	2100	60	14.4	0.0	13.4	14.2	14.0	0.0	0.0	14.0	0.0	14.2	14.5	0.0	0.0	14.3	13.6	0.0
5/5/2002	2200	60	13.7	0.0	12.9	14.0	13.9	0.0	0.0	13.8	0.0	13.4	14.2	0.0	0.0	14.0	13.8	0.0
5/5/2002	2300	60	12.4	0.0	11.8	0.0	12.2	0.0	0.0	12.3	0.0	12.2	12.7	0.0	0.0	12.3	12.0	0.0
5/6/2002	0000	60	13.8	0.0	12.8	0.0	13.2	0.0	0.0	13.6	0.0	13.3	0.0	0.0	0.0	13.2	0.0	0.0
5/6/2002	0100	60	14.3	0.0	13.8	0.0	14.7	0.0	0.0	14.2	0.0	13.8	0.0	0.0	0.0	14.9	0.0	0.0
5/6/2002	0200	60	13.9	0.0	13.0	0.0	12.9	0.0	0.0	13.6	0.0	12.8	0.0	0.0	0.0	13.4	0.0	13.2
5/6/2002	0300	60	13.4	0.0	13.3	0.0	12.9	0.0	0.0	13.4	0.0	12.7	0.0	0.0	0.0	13.2	0.0	13.3
5/6/2002	0400	60	13.7	0.0	13.4	0.0	12.9	0.0	0.0	13.7	0.0	12.7	0.0	0.0	0.0	13.3	0.0	13.1
5/6/2002	0500	60	13.5	0.0	13.1	0.0	13.1	0.0	0.0	13.6	0.0	12.8	0.0	0.0	0.0	13.3	0.0	13.2

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
5/6/2002	0600	60	14.9	0.0	14.8	0.0	14.9	0.0	0.0	14.5	0.0	14.7	0.0	0.0	0.0	15.1	0.0	15.0
5/7/2002	1900	60	14.9	0.0	13.5	0.0	13.5	0.0	0.0	13.5	0.0	13.4	13.6	0.0	0.0	0.0	13.1	0.0
5/7/2002	2000	60	13.6	0.0	13.3	0.0	14.1	0.0	0.0	14.0	0.0	13.9	14.0	0.0	0.0	0.0	13.7	0.0
5/7/2002	2100	60	13.9	0.0	18.1	0.0	18.5	0.0	0.0	18.2	0.0	18.4	18.7	0.0	0.0	0.0	18.3	0.0
5/7/2002	2200	60	13.7	0.0	14.4	0.0	15.1	0.0	0.0	14.5	0.0	14.9	15.2	0.0	0.0	14.8	14.8	0.0
5/7/2002	2300	60	13.5	0.0	14.2	0.0	14.1	0.0	0.0	14.6	0.0	14.2	14.8	0.0	0.0	14.8	14.5	0.0
5/8/2002	0000	60	13.5	0.0	13.4	0.0	13.3	0.0	0.0	12.8	0.0	13.6	13.4	0.0	0.0	13.5	13.3	0.0
5/8/2002	0100	60	13.6	0.0	13.5	0.0	12.9	0.0	0.0	13.3	0.0	12.9	13.4	0.0	0.0	13.6	12.7	0.0
5/8/2002	0200	60	13.4	0.0	12.7	0.0	13.0	0.0	0.0	12.4	0.0	13.4	12.9	0.0	0.0	12.6	0.0	0.0
5/8/2002	0300	60	13.1	0.0	12.5	0.0	12.8	0.0	0.0	12.5	0.0	12.3	12.8	0.0	0.0	12.4	0.0	0.0
5/8/2002	0400	60	12.9	0.0	12.7	0.0	12.4	0.0	0.0	12.6	0.0	12.0	13.3	0.0	0.0	12.3	0.0	0.0
5/8/2002	0500	60	12.8	0.0	12.3	0.0	13.3	0.0	0.0	12.6	0.0	12.7	13.0	0.0	0.0	13.0	0.0	0.0
5/8/2002	0600	60	13.3	0.0	12.9	0.0	12.4	0.0	0.0	12.3	0.0	12.1	12.4	0.0	0.0	13.0	0.0	0.0
5/9/2002	1900	30	14.8	0.0	13.5	13.6	13.7	0.0	0.0	13.6	14.4	13.9	0.0	13.7	0.0	13.9	13.9	0.0
5/9/2002	2000	30	14.8	0.0	14.1	14.6	13.7	0.0	0.0	14.2	14.2	13.8	0.0	14.4	0.0	14.1	13.7	0.0
5/9/2002	2100	30	14.7	0.0	13.3	14.4	14.2	0.0	0.0	14.3	14.2	14.0	0.0	14.3	0.0	14.3	14.3	0.0
5/9/2002	2200	30	14.9	0.0	13.7	14.1	14.0	0.0	0.0	14.8	14.3	14.0	0.0	13.7	0.0	14.3	14.0	0.0
5/9/2002	2300	30	15.0	0.0	13.5	14.3	14.2	0.0	0.0	13.4	14.6	14.4	0.0	13.4	0.0	14.6	13.1	0.0
5/10/2002	0000	30	14.8	0.0	12.9	14.4	13.5	0.0	0.0	14.0	13.9	13.5	0.0	13.6	0.0	13.6	14.0	0.0
5/10/2002	0100	30	15.2	0.0	13.3	13.0	13.5	0.0	0.0	13.0	13.8	13.4	0.0	12.1	0.0	13.6	12.7	0.0
5/10/2002	0200	30	15.2	0.0	13.1	13.2	13.4	0.0	0.0	12.6	13.9	13.5	0.0	13.1	0.0	13.6	13.1	0.0
5/10/2002	0300	30	15.2	0.0	14.9	15.4	15.1	0.0	0.0	14.6	15.5	14.9	0.0	15.3	0.0	0.0	15.6	0.0
5/10/2002	0400	30	15.1	0.0	15.1	15.3	15.7	0.0	0.0	15.8	15.4	15.4	0.0	14.8	0.0	0.0	15.6	0.0
5/10/2002	0500	30	14.7	0.0	15.1	15.5	15.8	0.0	0.0	15.6	16.1	15.6	0.0	15.1	0.0	0.0	15.6	0.0
5/10/2002	0600	30	15.2	0.0	14.2	15.1	15.1	0.0	0.0	14.7	14.6	14.5	0.0	14.8	0.0	14.5	14.3	0.0
5/11/2002	1900	30	13.2	0.0	11.6	0.0	11.9	0.0	0.0	11.9	0.0	11.7	13.1	0.0	0.0	12.2	11.8	0.0
5/11/2002	2000	30	13.1	0.0	12.3	0.0	12.8	0.0	0.0	13.1	0.0	1.6	13.5	0.0	0.0	13.6	12.4	0.0

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
5/11/2002	2100	30	13.2	0.0	15.2	0.0	15.5	0.0	0.0	15.7	0.0	15.7	16.0	0.0	0.0	16.3	15.3	0.0
5/11/2002	2200	30	13.2	0.0	12.4	0.0	12.9	0.0	0.0	13.3	0.0	12.4	13.3	0.0	0.0	12.8	12.1	12.9
5/11/2002	2300	30	13.4	0.0	12.3	0.0	12.4	0.0	0.0	12.3	0.0	12.7	12.1	0.0	0.0	12.4	12.5	12.5
5/12/2002	0000	30	13.7	0.0	14.2	0.0	14.9	0.0	0.0	15.1	0.0	15.0	0.0	0.0	0.0	0.0	14.9	15.4
5/12/2002	0100	30	13.5	0.0	14.4	0.0	15.4	0.0	0.0	15.6	0.0	15.2	0.0	0.0	0.0	0.0	14.5	15.5
5/12/2002	0200	30	13.4	0.0	14.5	0.0	15.4	0.0	0.0	15.4	0.0	15.0	0.0	0.0	0.0	0.0	15.3	15.4
5/12/2002	0300	30	13.6	0.0	15.0	0.0	15.0	0.0	0.0	15.0	0.0	14.9	0.0	0.0	0.0	0.0	15.2	15.5
5/12/2002	0400	30	13.4	0.0	15.1	0.0	15.3	0.0	0.0	15.0	0.0	15.7	0.0	0.0	0.0	0.0	15.7	15.0
5/12/2002	0500	30	13.6	0.0	14.2	0.0	15.2	0.0	0.0	15.2	0.0	14.7	0.0	0.0	0.0	15.1	14.4	14.9
5/12/2002	0600	30	13.3	0.0	12.6	0.0	13.4	13.5	0.0	12.7	13.7	13.0	13.1	0.0	0.0	13.3	0.0	13.1
5/13/2002	1900	60	15.2	0.0	0.0	12.9	13.6	0.0	0.0	13.7	0.0	12.5	0.0	12.4	0.0	0.0	0.0	13.4
5/13/2002	2000	60	13.2	0.0	0.0	13.7	13.8	0.0	0.0	13.4	0.0	13.4	0.0	0.0	0.0	0.0	0.0	13.8
5/13/2002	2100	60	15.9	0.0	0.0	15.7	15.4	0.0	0.0	15.5	0.0	15.2	0.0	0.0	0.0	0.0	0.0	15.4
5/13/2002	2200	60	15.1	0.0	0.0	15.0	14.7	0.0	0.0	15.3	0.0	15.1	0.0	0.0	0.0	0.0	0.0	15.2
5/13/2002	2300	60	11.9	0.0	0.0	11.9	11.9	0.0	0.0	12.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	12.0
5/14/2002	0000	60	12.3	0.0	0.0	11.9	12.1	0.0	0.0	11.9	0.0	12.1	0.0	0.0	0.0	0.0	0.0	12.2
5/14/2002	0100	60	12.2	0.0	0.0	12.3	12.3	0.0	0.0	11.9	0.0	12.1	0.0	0.0	0.0	0.0	0.0	12.0
5/14/2002	0200	60	13.9	0.0	0.0	0.0	13.5	0.0	0.0	13.2	0.0	13.8	0.0	0.0	0.0	0.0	0.0	13.9
5/14/2002	0300	60	14.8	0.0	0.0	0.0	13.4	0.0	0.0	13.7	0.0	13.3	0.0	0.0	0.0	0.0	0.0	14.1
5/14/2002	0400	60	14.7	0.0	0.0	0.0	13.6	0.0	0.0	13.8	0.0	14.1	0.0	0.0	0.0	0.0	0.0	14.3
5/14/2002	0500	60	13.3	0.0	12.8	0.0	13.1	0.0	0.0	12.5	0.0	13.5	0.0	0.0	0.0	0.0	0.0	12.9
5/14/2002	0600	60	15.0	0.0	14.2	0.0	14.7	0.0	0.0	13.8	0.0	14.0	0.0	0.0	0.0	0.0	0.0	14.5
5/15/2002	1900	60	13.7	0.0	0.0	12.6	12.8	0.0	0.0	12.2	13.1	0.0	12.7	0.0	0.0	0.0	0.0	12.8
5/15/2002	2000	60	13.3	0.0	0.0	12.4	12.4	0.0	0.0	12.6	13.1	0.0	12.6	0.0	0.0	0.0	0.0	12.6
5/15/2002	2100	60	14.2	0.0	0.0	13.7	13.3	0.0	0.0	13.7	13.8	0.0	13.9	0.0	0.0	0.0	0.0	13.6
5/15/2002	2200	60	13.7	0.0	0.0	13.1	13.5	0.0	0.0	13.4	13.8	0.0	14.2	0.0	0.0	0.0	0.0	13.8
5/15/2002	2300	60	13.8	0.0	0.0	13.7	13.0	0.0	0.0	13.7	13.4	0.0	13.6	0.0	0.0	0.0	0.0	13.1

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
5/16/2002	0000	60	14.1	0.0	0.0	13.8	13.7	0.0	0.0	13.7	14.2	0.0	14.0	0.0	0.0	0.0	0.0	13.9
5/16/2002	0100	60	14.7	0.0	0.0	13.8	14.3	0.0	0.0	14.2	14.3	0.0	14.4	0.0	0.0	0.0	0.0	14.4
5/16/2002	0200	60	12.3	0.0	0.0	12.5	12.2	0.0	0.0	12.7	13.0	0.0	12.9	0.0	0.0	0.0	0.0	12.7
5/16/2002	0300	60	12.1	0.0	0.0	12.1	12.1	0.0	0.0	12.1	12.3	0.0	12.3	0.0	0.0	0.0	0.0	12.3
5/16/2002	0400	60	12.5	0.0	0.0	12.3	12.2	0.0	0.0	12.1	12.3	0.0	12.5	0.0	0.0	0.0	0.0	12.2
5/16/2002	0500	60	12.2	0.0	0.0	12.3	12.1	0.0	0.0	12.1	12.2	0.0	12.7	0.0	0.0	0.0	0.0	12.2
5/16/2002	0600	60	12.3	0.0	0.0	12.3	12.3	0.0	0.0	12.0	12.3	0.0	12.3	0.0	0.0	0.0	0.0	12.1
5/17/2002	1900	30	13.4	14.8	0.0	15.3	15.0	0.0	0.0	15.4	0.0	14.8	0.0	15.1	0.0	0.0	15.7	15.1
5/17/2002	2000	30	13.8	15.8	0.0	14.9	16.0	0.0	0.0	15.1	0.0	15.6	0.0	16.0	0.0	0.0	15.1	15.6
5/17/2002	2100	30	13.7	17.1	0.0	17.5	17.3	0.0	0.0	16.9	0.0	17.0	0.0	17.4	0.0	0.0	17.0	17.2
5/17/2002	2200	30	13.7	15.9	11.5	15.9	15.8	0.0	0.0	15.4	0.0	15.7	0.0	16.5	0.0	0.0	16.0	16.6
5/17/2002	2300	30	13.3	14.7	14.3	15.5	14.4	0.0	0.0	14.9	0.0	14.9	0.0	14.9	0.0	0.0	15.0	15.1
5/18/2002	0000	30	13.5	15.4	15.2	15.6	15.2	0.0	0.0	15.4	0.0	15.2	0.0	15.1	0.0	0.0	15.4	15.6
5/18/2002	0100	30	13.8	15.7	14.8	15.6	15.4	0.0	0.0	15.2	0.0	15.6	0.0	14.9	0.0	0.0	15.0	15.2
5/18/2002	0200	30	13.7	16.3	15.5	17.1	16.4	0.0	0.0	16.2	0.0	16.5	0.0	16.7	0.0	0.0	15.9	17.0
5/18/2002	0300	30	13.7	15.5	15.6	16.3	16.4	0.0	0.0	16.2	0.0	15.8	0.0	16.1	0.0	0.0	16.2	15.9
5/18/2002	0400	30	13.8	16.4	16.3	17.3	16.6	0.0	0.0	16.3	0.0	16.6	0.0	16.7	0.0	0.0	16.1	16.6
5/18/2002	0500	30	13.7	16.4	15.8	16.4	16.2	0.0	0.0	16.2	0.0	16.6	0.0	15.9	0.0	0.0	15.8	17.0
5/18/2002	0600	30	13.6	16.4	16.2	16.3	16.7	0.0	0.0	16.5	0.0	16.6	0.0	16.9	0.0	0.0	16.5	16.7
5/19/2002	1900	30	14.6	17.0	16.7	0.0	17.2	0.0	0.0	16.9	17.5	0.0	17.2	17.8	0.0	17.6	17.1	0.0
5/19/2002	2000	30	15.2	16.1	16.0	0.0	16.4	0.0	0.0	17.3	16.8	16.5	16.6	16.1	0.0	16.7	16.4	0.0
5/19/2002	2100	30	15.1	15.9	15.8	0.0	16.3	0.0	0.0	15.7	16.9	16.2	16.6	15.9	0.0	16.6	16.2	0.0
5/19/2002	2200	30	17.3	16.8	16.2	0.0	16.9	0.0	0.0	17.0	17.4	16.9	17.3	16.6	0.0	16.6	17.0	17.1
5/19/2002	2300	30	16.1	15.5	15.3	0.0	15.4	0.0	0.0	15.5	16.2	15.6	15.7	15.5	0.0	15.5	15.6	15.9
5/20/2002	0000	30	14.8	14.3	14.1	0.0	14.2	0.0	0.0	13.8	14.6	14.1	14.7	14.5	0.0	14.1	14.0	14.4
5/20/2002	0100	30	15.0	14.1	13.8	0.0	14.5	0.0	0.0	14.7	14.9	14.4	15.1	14.3	0.0	14.4	13.7	14.8
5/20/2002	0200	30	15.4	14.8	13.9	0.0	14.5	0.0	0.0	14.7	14.8	14.9	14.9	14.6	0.0	14.3	14.4	15.1

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
5/20/2002	0300	30	14.7	14.1	13.8	0.0	13.8	0.0	0.0	13.9	14.7	14.7	14.2	14.0	0.0	14.3	14.8	14.7
5/20/2002	0400	30	14.7	14.2	13.9	0.0	13.8	0.0	0.0	14.0	15.0	13.8	15.0	14.2	0.0	14.5	14.5	14.5
5/20/2002	0500	30	14.9	13.9	13.7	0.0	14.2	0.0	0.0	14.5	14.5	14.2	14.2	14.4	0.0	14.5	14.2	13.9
5/20/2002	0600	30	15.2	14.0	13.8	0.0	14.6	0.0	0.0	14.3	15.0	14.0	15.2	14.2	0.0	14.4	14.2	14.4
5/21/2002	1900	60	13.8	0.0	13.1	0.0	13.8	0.0	21.9	0.0	0.0	13.8	0.0	0.0	0.0	14.1	13.7	0.0
5/21/2002	2000	60	17.2	0.0	16.8	0.0	17.4	0.0	21.8	0.0	0.0	16.7	0.0	0.0	0.0	17.1	17.1	0.0
5/21/2002	2100	60	17.8	0.0	17.2	0.0	17.7	0.0	22.1	0.0	0.0	16.9	0.0	17.5	0.0	17.7	17.7	0.0
5/21/2002	2200	60	17.6	0.0	16.7	0.0	17.2	0.0	21.9	0.0	0.0	16.8	0.0	17.3	0.0	16.7	16.7	0.0
5/21/2002	2300	60	17.6	0.0	16.7	0.0	17.2	0.0	21.9	0.0	0.0	16.8	0.0	17.3	0.0	16.7	16.7	0.0
5/22/2002	0000	60	14.2	0.0	13.5	0.0	14.0	0.0	21.7	0.0	0.0	13.4	0.0	13.5	0.0	13.9	13.8	0.0
5/22/2002	0100	60	14.1	0.0	13.7	0.0	13.2	0.0	21.7	0.0	0.0	14.2	0.0	13.8	0.0	13.6	13.6	0.0
5/22/2002	0200	60	14.6	0.0	14.0	0.0	14.3	0.0	21.6	0.0	0.0	14.1	0.0	14.3	0.0	14.9	14.1	0.0
5/22/2002	0300	60	14.6	0.0	14.6	0.0	14.0	0.0	21.8	0.0	0.0	14.7	0.0	14.0	0.0	14.5	14.3	0.0
5/22/2002	0400	60	12.1	0.0	12.1	0.0	12.3	0.0	21.6	0.0	0.0	11.9	0.0	12.4	0.0	12.4	12.0	0.0
5/22/2002	0500	60	13.8	0.0	12.2	0.0	12.3	0.0	21.8	0.0	12.4	0.0	0.0	12.2	0.0	12.2	12.0	0.0
5/22/2002	0600	60	13.8	0.0	12.8	0.0	12.7	0.0	21.5	0.0	13.2	0.0	0.0	13.1	0.0	12.7	12.8	0.0
5/23/2002	1900	60	12.7	13.1	12.6	12.8	12.8	0.0	22.2	0.0	0.0	12.7	13.0	0.0	0.0	12.9	12.5	0.0
5/23/2002	2000	60	12.6	12.4	12.7	12.4	12.4	0.0	22.0	0.0	0.0	13.4	12.9	0.0	0.0	12.4	12.4	0.0
5/23/2002	2100	60	12.6	12.2	12.3	12.4	12.4	0.0	22.1	0.0	0.0	12.4	13.0	0.0	0.0	12.7	12.3	0.0
5/23/2002	2200	60	12.9	12.7	12.6	12.5	12.8	0.0	21.9	0.0	0.0	12.6	13.1	0.0	0.0	13.0	12.7	0.0
5/23/2002	2300	60	12.7	12.1	12.1	12.6	12.3	0.0	21.7	0.0	0.0	12.5	12.8	0.0	0.0	12.4	12.3	0.0
5/24/2002	0000	60	12.3	12.2	12.0	0.0	12.4	0.0	21.7	0.0	0.0	12.2	12.2	0.0	0.0	12.5	12.3	0.0
5/24/2002	0100	60	12.4	0.0	12.1	0.0	12.2	0.0	21.6	0.0	0.0	12.0	2.4	0.0	0.0	12.2	12.0	0.0
5/24/2002	0200	60	13.5	0.0	13.0	0.0	13.3	0.0	21.6	0.0	0.0	13.0	0.0	0.0	0.0	13.5	13.0	0.0
5/24/2002	0300	60	13.4	0.0	13.4	0.0	13.2	0.0	21.5	0.0	0.0	13.0	0.0	0.0	0.0	13.8	12.7	0.0
5/24/2002	0400	60	13.7	0.0	13.4	0.0	14.0	0.0	21.5	0.0	0.0	13.7	0.0	0.0	0.0	13.7	13.6	0.0
5/24/2002	0500	60	12.8	0.0	12.1	0.0	13.0	0.0	21.5	0.0	0.0	12.3	13.2	0.0	0.0	13.0	12.6	0.0

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
5/24/2002	0600	60	13.8	0.0	14.4	0.0	14.6	0.0	21.8	0.0	0.0	14.3	14.9	0.0	0.0	14.8	14.2	0.0
5/25/2002	1900	30	14.8	12.3	12.2	0.0	12.4	13.5	21.3	0.0	13.5	13.0	0.0	12.8	0.0	13.0	12.0	0.0
5/25/2002	2000	30	13.6	12.8	12.7	0.0	12.5	13.1	21.7	0.0	13.4	12.6	0.0	13.1	0.0	13.0	12.9	0.0
5/25/2002	2100	30	13.4	13.5	12.9	0.0	13.2	13.2	21.8	0.0	14.1	13.4	0.0	13.2	0.0	13.1	12.6	0.0
5/25/2002	2200	30	13.5	13.7	13.6	0.0	13.9	13.2	21.4	0.0	14.6	14.0	0.0	13.4	0.0	14.1	13.3	0.0
5/25/2002	2300	30	12.6	12.6	12.6	0.0	12.6	12.5	21.2	0.0	12.9	12.0	0.0	12.1	0.0	12.8	12.5	0.0
5/26/2002	0000	30	12.4	12.7	12.3	0.0	12.8	12.8	21.3	0.0	12.9	12.1	0.0	12.2	0.0	12.5	12.0	0.0
5/26/2002	0100	30	12.5	13.4	12.2	0.0	12.8	12.6	21.5	0.0	13.0	12.1	0.0	12.6	0.0	12.6	12.0	0.0
5/26/2002	0200	30	13.1	12.3	12.3	0.0	12.8	12.6	21.4	0.0	12.9	12.1	0.0	12.7	0.0	12.7	12.8	0.0
5/26/2002	0300	30	12.2	12.5	12.7	0.0	13.3	12.9	21.2	0.0	13.1	12.2	0.0	12.2	0.0	12.5	13.0	0.0
5/26/2002	0400	30	12.4	12.2	12.9	0.0	13.2	12.3	21.5	0.0	13.1	12.0	0.0	12.2	0.0	12.7	13.0	0.0
5/26/2002	0500	30	12.2	12.2	12.5	0.0	12.3	12.4	21.5	0.0	13.0	12.1	0.0	12.6	0.0	12.5	12.7	0.0
5/26/2002	0600	30	12.1	12.2	12.8	0.0	12.4	12.3	21.4	0.0	13.0	12.1	0.0	12.5	0.0	12.5	12.8	0.0
5/27/2002	1900	30	15.5	0.0	16.2	17.0	16.7	16.9	0.0	17.1	17.5	16.4	17.7	0.0	0.0	17.4	16.7	0.0
5/27/2002	2000	30	15.4	0.0	17.0	16.9	16.8	17.4	0.0	16.9	17.5	16.8	17.2	0.0	0.0	17.2	17.3	0.0
5/27/2002	2100	30	15.2	0.0	14.6	15.5	15.6	14.8	14.0	14.8	16.1	15.5	15.7	0.0	0.0	15.9	15.4	0.0
5/27/2002	2200	30	15.2	0.0	14.0	14.2	14.1	14.9	22.0	14.5	14.8	14.3	14.9	0.0	0.0	14.6	14.3	0.0
5/27/2002	2300	30	15.1	0.0	15.9	16.2	16.8	16.2	0.0	15.8	16.4	16.5	16.6	0.0	0.0	17.3	16.0	0.0
5/28/2002	0000	30	15.2	0.0	16.5	16.3	16.7	16.4	0.0	16.3	17.1	16.7	17.5	0.0	0.0	16.3	15.9	0.0
5/28/2002	0100	30	15.3	0.0	15.2	15.6	15.7	15.8	22.0	15.4	16.0	15.5	15.5	0.0	0.0	16.0	15.3	0.0
5/28/2002	0200	30	15.4	0.0	14.9	14.8	14.8	15.0	21.8	14.2	15.1	14.6	14.9	0.0	0.0	15.0	14.7	0.0
5/28/2002	0300	30	15.6	16.2	16.4	16.5	16.8	17.1	22.4	16.6	17.0	16.4	16.6	0.0	0.0	17.0	15.8	0.0
5/28/2002	0400	30	14.9	17.2	17.2	17.3	17.4	17.4	22.0	17.1	18.0	17.4	17.9	0.0	0.0	17.7	16.5	0.0
5/28/2002	0500	30	14.8	17.6	17.1	17.7	18.3	17.6	22.1	17.6	18.0	17.8	18.1	0.0	0.0	18.1	17.4	0.0
5/28/2002	0600	30	14.6	16.6	16.2	16.8	16.8	16.5	22.1	16.5	17.1	16.5	16.8	0.0	0.0	17.2	16.3	0.0
5/29/2002	1900	60	14.2	17.9	17.6	18.1	17.8	17.6	0.0	17.8	18.2	17.5	18.2	17.7	0.0	19.0	18.0	0.0
5/29/2002	2000	60	13.1	12.6	12.5	12.7	12.7	12.6	0.0	12.6	13.1	12.4	12.7	12.3	0.0	12.9	12.2	0.0

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
5/29/2002	2100	60	14.1	0.0	0.0	14.1	13.9	14.4	22.6	13.9	14.7	14.2	14.3	13.7	0.0	14.1	13.5	0.0
5/29/2002	2200	60	14.2	0.0	0.0	13.7	13.9	13.6	22.3	14.0	14.0	14.7	14.4	14.2	0.0	14.5	13.8	0.0
5/29/2002	2300	60	15.9	0.0	0.0	15.7	15.3	0.0	0.0	0.0	15.5	15.6	15.5	15.0	0.0	15.5	15.2	0.0
5/30/2002	0000	60	13.2	0.0	0.0	13.2	13.4	0.0	21.8	0.0	0.0	12.9	0.0	13.1	0.0	13.5	0.0	0.0
5/30/2002	0100	60	14.3	0.0	0.0	14.4	13.9	0.0	22.2	0.0	0.0	14.2	0.0	14.6	0.0	14.2	0.0	0.0
5/30/2002	0200	60	13.8	0.0	0.0	13.6	13.9	0.0	22.0	0.0	0.0	14.0	0.0	14.1	0.0	14.3	0.0	0.0
5/30/2002	0300	60	14.0	0.0	0.0	14.3	13.6	0.0	21.9	0.0	0.0	13.9	0.0	14.3	0.0	14.2	0.0	0.0
5/30/2002	0400	60	14.0	0.0	0.0	14.3	14.9	0.0	21.8	0.0	0.0	13.7	0.0	13.9	0.0	14.0	0.0	0.0
5/30/2002	0500	60	14.5	0.0	0.0	14.2	14.6	0.0	22.1	0.0	0.0	13.7	0.0	13.7	0.0	14.1	0.0	0.0
5/30/2002	0600	60	17.4	0.0	0.0	17.2	17.6	0.0	22.2	0.0	0.0	17.2	0.0	17.4	0.0	17.6	16.9	0.0
6/29/2002	1900	60	14.0	12.8	12.7	13.4	13.5	13.0	13.1	12.6	13.5	13.3	13.7	13.0	13.4	0.0	12.8	0.0
6/29/2002	2000	60	13.7	12.7	12.5	13.5	13.5	12.9	13.2	12.6	13.6	13.4	13.8	13.1	13.4	0.0	12.7	0.0
6/29/2002	2100	60	13.4	12.5	12.7	12.7	12.6	12.9	13.0	12.6	13.4	12.6	13.0	13.0	13.1	0.0	12.3	0.0
6/29/2002	2200	60	13.5	12.5	12.8	12.7	12.7	12.7	13.0	12.3	13.3	12.7	12.7	13.0	13.3	0.0	12.6	0.0
6/29/2002	2300	60	12.8	12.6	12.9	12.6	12.9	12.9	12.9	12.7	13.4	12.6	13.1	12.8	13.0	0.0	12.6	0.0
6/29/2002	0000	60	12.7	0.0	12.1	12.5	12.4	12.5	12.9	12.6	12.9	12.5	0.0	12.4	12.5	0.0	12.2	0.0
6/30/2002	0100	60	12.3	0.0	12.3	12.7	12.5	12.6	12.6	12.5	12.9	12.5	0.0	0.0	13.0	0.0	12.2	0.0
6/30/2002	0200	60	12.5	0.0	12.0	12.5	12.5	12.5	12.6	12.4	12.7	12.4	0.0	0.0	12.6	0.0	12.1	0.0
6/30/2002	0300	60	12.4	0.0	12.5	12.4	12.5	12.7	12.6	12.3	12.6	12.4	0.0	0.0	12.5	0.0	12.2	0.0
6/30/2002	0400	60	12.5	0.0	11.9	12.3	12.4	12.4	12.6	12.2	12.7	12.3	0.0	0.0	12.3	0.0	12.2	0.0
6/30/2002	0500	60	12.8	0.0	12.2	12.5	12.2	12.2	12.4	12.3	12.6	12.2	0.0	0.0	12.3	0.0	12.2	0.0
6/30/2002	0600	60	15.3	20.6	19.2	19.9	20.0	20.2	20.5	19.9	20.7	19.3	20.4	19.4	20.4	0.0	19.9	0.0
7/1/2002	1900	30	15.1	16.9	16.4	17.0	16.8	17.3	0.0	17.2	17.1	16.6	17.5	16.8	17.0	0.0	16.7	0.0
7/1/2002	2000	30	16.2	16.1	15.8	16.4	16.4	17.0	21.9	16.3	16.8	16.3	16.7	16.7	16.2	0.0	16.4	0.0
7/1/2002	2100	30	16.8	16.4	15.9	16.6	16.3	16.3	21.8	16.4	16.7	16.4	16.4	15.6	16.3	0.0	16.2	0.0
7/1/2002	2200	30	17.7	17.0	17.5	17.5	17.4	16.7	0.0	17.1	17.8	17.5	17.4	17.4	17.1	0.0	17.2	0.0
7/1/2002	2300	30	13.8	13.5	13.2	13.5	13.3	13.2	13.1	12.7	13.7	13.5	13.2	13.2	12.9	0.0	12.8	0.0

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
7/2/2002	0000	30	13.7	13.0	13.5	13.7	13.9	13.6	14.2	14.0	13.9	13.4	14.0	14.2	13.7	0.0	13.8	0.0
7/2/2002	0100	30	13.4	13.2	12.8	13.1	13.2	12.9	13.1	13.0	13.3	12.6	0.0	13.2	13.3	0.0	12.2	0.0
7/2/2002	0200	30	13.5	13.6	13.8	13.6	13.8	13.2	13.4	13.4	13.7	13.6	0.0	13.4	14.4	0.0	13.8	0.0
7/2/2002	0300	30	12.3	0.0	12.4	12.6	12.6	0.0	12.8	0.0	0.0	12.4	0.0	0.0	0.0	0.0	12.1	0.0
7/2/2002	0400	30	12.8	0.0	12.2	12.3	12.8	0.0	12.5	0.0	0.0	12.5	0.0	0.0	0.0	0.0	12.3	0.0
7/2/2002	0500	30	12.9	0.0	12.0	12.3	12.4	0.0	12.2	0.0	0.0	12.3	0.0	0.0	0.0	0.0	12.1	0.0
7/2/2002	0600	30	15.1	14.8	15.1	15.1	14.8	14.7	15.2	14.9	15.7	15.3	0.0	0.0	16.0	0.0	15.1	0.0
7/9/2002	1900	60	13.7	0.0	16.9	16.8	16.4	0.0	0.0	16.3	17.2	0.0	17.0	0.0	17.6	0.0	16.9	0.0
7/9/2002	2000	60	12.7	0.0	11.8	12.6	12.4	0.0	22.0	0.0	12.6	0.0	12.6	0.0	12.9	0.0	12.2	0.0
7/9/2002	2100	60	12.9	0.0	0.0	12.8	12.1	0.0	21.2	0.0	12.9	0.0	12.6	0.0	0.0	0.0	13.2	0.0
7/9/2002	2200	60	12.8	0.0	0.0	13.0	12.6	0.0	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0
7/9/2002	2300	60	13.4	0.0	0.0	13.2	12.7	0.0	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	12.3	0.0
7/10/2002	0000	60	14.0	0.0	0.0	13.8	14.2	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	14.3	0.0
7/10/2002	0100	60	14.2	0.0	0.0	14.0	14.0	0.0	0.0	0.0	14.2	0.0	0.0	0.0	0.0	0.0	13.5	0.0
7/10/2002	0200	60	12.5	0.0	0.0	12.8	12.3	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0	13.0	0.0
7/10/2002	0300	60	12.5	0.0	0.0	12.7	12.8	0.0	0.0	0.0	13.1	0.0	0.0	0.0	0.0	0.0	12.2	0.0
7/10/2002	0400	60	13.0	0.0	0.0	12.9	12.5	0.0	0.0	0.0	13.2	0.0	0.0	0.0	0.0	0.0	12.6	0.0
7/10/2002	0500	60	12.1	0.0	0.0	12.3	12.3	0.0	0.0	0.0	12.3	0.0	0.0	0.0	0.0	0.0	12.2	0.0
7/10/2002	0600	60	13.5	0.0	0.0	15.5	15.0	15.7	0.0	15.5	15.8	0.0	15.6	0.0	15.4	0.0	14.8	0.0
7/11/2002	1900	60	13.5	12.2	13.1	13.2	12.4	0.0	12.8	13.0	13.3	12.5	12.4	12.5	13.1	0.0	12.5	0.0
7/11/2002	2000	60	13.4	12.7	13.3	13.2	12.6	0.0	12.6	13.2	13.4	12.6	12.8	12.6	13.1	0.0	12.7	0.0
7/11/2002	2100	60	13.4	12.2	13.1	13.1	12.5	0.0	12.7	13.0	13.4	12.4	12.7	12.5	13.1	0.0	12.3	0.0
7/11/2002	2200	60	14.8	13.7	13.9	14.5	14.1	0.0	14.4	14.6	14.8	14.5	15.0	14.8	14.8	0.0	14.9	0.0
7/11/2002	2300	60	13.2	12.6	13.0	0.0	12.6	0.0	13.0	12.6	13.0	0.0	13.0	0.0	13.0	0.0	12.8	0.0
7/12/2002	0000	60	13.2	0.0	12.1	0.0	12.5	0.0	13.3	0.0	13.5	0.0	0.0	0.0	13.4	0.0	13.4	0.0
7/12/2002	0100	60	12.1	0.0	11.7	0.0	12.0	0.0	12.3	0.0	12.5	0.0	0.0	0.0	0.0	0.0	12.1	0.0
7/12/2002	0200	60	11.9	0.0	0.0	0.0	11.9	0.0	12.1	0.0	12.1	0.0	0.0	0.0	0.0	0.0	11.8	0.0

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
7/12/2002	0300	60	12.1	0.0	0.0	0.0	12.0	0.0	12.3	0.0	12.2	0.0	0.0	0.0	0.0	0.0	12.0	0.0
7/12/2002	0400	60	12.8	0.0	0.0	0.0	12.0	0.0	12.1	0.0	12.9	0.0	0.0	0.0	0.0	0.0	12.6	0.0
7/12/2002	0500	60	13.1	0.0	0.0	0.0	13.0	0.0	13.4	0.0	13.2	0.0	0.0	0.0	0.0	0.0	12.9	0.0
7/12/2002	0600	60	14.8	15.7	15.6	15.7	15.7	15.7	15.7	0.0	16.0	0.0	16.3	15.5	16.5	0.0	15.9	0.0
7/13/2002	1900	30	15.8	15.0	14.9	15.3	15.2	15.4	15.7	15.0	15.4	15.5	14.9	15.1	16.0	0.0	15.7	0.0
7/13/2002	2000	30	15.3	14.9	14.9	14.8	14.8	15.0	15.6	15.4	15.0	15.0	15.4	14.8	14.8	0.0	14.7	0.0
7/13/2002	2100	30	15.5	15.4	14.7	16.1	15.6	16.3	16.2	15.8	15.4	15.8	16.0	15.9	16.5	0.0	16.0	0.0
7/13/2002	2200	30	13.9	13.3	12.6	13.4	13.4	13.3	13.2	13.5	12.7	12.7	13.3	13.3	13.4	0.0	13.0	0.0
7/13/2002	2300	30	14.8	14.1	14.3	14.5	14.8	14.7	14.3	14.7	14.6	14.3	14.8	0.0	15.3	0.0	13.7	0.0
7/14/2002	0000	30	14.7	14.5	14.6	14.4	14.5	14.4	15.1	15.0	15.1	14.4	14.7	0.0	15.8	0.0	14.0	0.0
7/14/2002	0100	30	13.8	13.5	13.1	13.6	13.1	12.9	12.7	13.2	13.4	13.2	13.3	0.0	13.5	0.0	13.1	0.0
7/14/2002	0200	30	12.8	12.8	12.3	12.5	12.5	12.8	12.7	12.6	12.6	12.6	12.7	0.0	13.0	0.0	12.3	0.0
7/14/2002	0300	30	13.2	12.5	12.3	12.8	12.4	12.3	12.7	12.7	12.6	12.3	12.7	0.0	13.2	0.0	13.1	0.0
7/14/2002	0400	30	12.8	12.3	12.7	12.8	12.5	12.4	12.5	12.7	12.7	12.5	13.2	0.0	0.0	0.0	12.8	0.0
7/14/2002	0500	30	12.5	12.0	12.0	12.4	12.4	12.1	12.8	12.2	12.3	12.2	12.5	0.0	0.0	0.0	12.3	0.0
7/14/2002	0600	30	13.8	13.2	12.8	13.1	13.0	13.0	13.1	0.0	0.0	12.9	13.3	0.0	0.0	0.0	13.1	0.0
7/15/2002	1900	60	13.5	0.0	0.0	14.1	13.7	0.0	14.4	0.0	14.4	0.0	0.0	0.0	13.7	0.0	13.6	0.0
7/15/2002	2000	60	14.0	0.0	0.0	13.9	14.1	0.0	13.7	0.0	14.0	0.0	14.0	0.0	13.9	0.0	13.8	0.0
7/15/2002	2100	60	15.0	0.0	0.0	14.5	14.9	0.0	14.6	0.0	14.8	0.0	14.9	0.0	14.5	0.0	14.7	0.0
7/15/2002	2200	60	16.1	0.0	0.0	14.8	15.5	0.0	15.2	0.0	15.4	0.0	0.0	0.0	15.8	0.0	14.8	0.0
7/15/2002	2300	60	13.3	0.0	0.0	12.9	12.7	0.0	12.7	0.0	13.2	0.0	0.0	0.0	0.0	0.0	13.2	0.0
7/16/2002	0000	60	12.4	0.0	0.0	12.1	11.9	0.0	12.1	0.0	12.2	0.0	0.0	0.0	0.0	0.0	12.0	0.0
7/16/2002	0100	60	12.2	0.0	0.0	12.3	11.8	0.0	12.2	0.0	12.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/16/2002	0200	60	13.0	0.0	0.0	12.4	13.2	0.0	12.9	0.0	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/16/2002	0300	60	12.9	0.0	0.0	12.7	12.8	0.0	12.3	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/16/2002	0400	60	12.5	0.0	0.0	12.7	12.8	0.0	12.9	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/16/2002	0500	60	13.4	0.0	0.0	13.8	13.5	0.0	14.1	0.0	13.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Release Date	Hour	Spill %	MU1 (kcfs)	MU2 (kcfs)	MU3 (kcfs)	MU4 (kcfs)	MU5 (kcfs)	MU6 (kcfs)	MU7 (kcfs)	MU8 (kcfs)	MU9 (kcfs)	MU10 (kcfs)	MU11 (kcfs)	MU12 (kcfs)	MU13 (kcfs)	MU14 (kcfs)	MU15 (kcfs)	MU16 (kcfs)
7/16/2002	0600	60	14.7	16.8	0.0	16.7	17.2	0.0	16.7	0.0	16.5	0.0	16.7	0.0	16.7	0.0	16.1	0.0
7/17/2002	1900	30	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	0.0	13.1	0.0
7/17/2002	2000	30	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	0.0	13.7	0.0
7/17/2002	2100	30	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	0.0	14.0	0.0
7/17/2002	2200	30	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	0.0	13.9	0.0
7/17/2002	2300	30	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	0.0	14.1	0.0
7/18/2002	0000	30	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	0.0	14.5	0.0
7/18/2002	0100	30	13.2	0.0	13.2	13.2	13.2	0.0	13.2	13.2	13.2	13.2	13.2	13.2	13.2	0.0	13.2	0.0
7/18/2002	0200	30	12.6	0.0	12.6	12.6	12.6	0.0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	0.0	12.6	0.0
7/18/2002	0300	30	12.7	0.0	12.7	12.7	12.7	0.0	12.7	12.7	12.7	12.7	12.7	12.7	12.7	0.0	12.7	0.0
7/18/2002	0400	30	12.9	0.0	12.9	12.9	12.9	0.0	12.9	12.9	12.9	12.9	12.9	12.9	12.9	0.0	12.9	0.0
7/18/2002	0500	30	12.9	0.0	12.9	12.9	12.9	0.0	12.9	12.9	12.9	12.9	12.9	12.9	12.9	0.0	12.9	0.0
7/18/2002	0600	30	13.1	0.0	13.1	13.1	13.1	0.0	13.1	13.1	13.1	13.1	13.1	13.1	13.1	0.0	13.1	0.0

Appendix 3. Spillway (SP) dam operations at John Day Dam during 2002 fish releases.

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
5/1/2002	1900	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/1/2002	2000	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/1/2002	2100	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/1/2002	2200	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/1/2002	2300	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/2/2002	0000	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/2/2002	0100	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/2/2002	0200	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/2/2002	0300	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/2/2002	0400	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/2/2002	0500	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/2/2002	0600	60	0.0	6.1	7.8	7.8	6.2	6.2	6.2	4.7	4.5	4.7	4.8	4.6	4.7	4.8	4.2	3.3	3.3	1.4	0.0	0.0
5/5/2002	1900	60	0.0	6.0	9.3	9.1	7.8	7.7	7.8	7.9	7.6	7.8	7.9	7.7	7.6	7.9	7.4	7.9	7.8	7.6	8.9	7.6
5/5/2002	2000	60	0.0	6.0	9.3	9.1	7.8	7.7	7.8	7.9	7.6	7.8	7.9	7.7	7.6	7.9	7.4	7.9	7.8	7.6	8.9	7.6
5/5/2002	2100	60	0.0	6.0	9.3	9.1	7.8	7.7	7.8	7.9	7.6	7.8	7.9	7.8	7.7	7.9	7.4	7.9	7.9	7.6	8.9	7.6
5/5/2002	2200	60	0.0	6.1	9.3	9.2	7.8	7.7	7.8	8.0	7.7	7.8	8.0	7.8	7.7	8.0	7.4	7.9	7.9	7.6	9.0	7.6
5/5/2002	2300	60	0.0	6.1	9.3	9.2	7.8	7.7	7.8	8.0	7.7	7.8	8.0	7.8	7.7	8.0	7.4	7.9	7.9	7.6	9.0	7.6
5/6/2002	0000	60	0.0	6.1	7.8	7.8	6.2	6.1	6.3	6.2	6.2	6.3	6.4	6.2	6.2	6.4	6.3	6.3	7.9	6.2	7.6	6.3
5/6/2002	0100	60	0.0	6.1	7.8	7.8	6.2	6.1	6.3	6.2	6.2	6.3	6.4	6.2	6.2	6.4	6.3	6.3	7.9	6.2	7.6	6.3
5/6/2002	0200	60	0.0	6.1	7.8	7.8	7.7	7.7	6.3	7.9	6.2	7.8	6.4	7.7	6.2	6.4	7.4	6.3	7.9	7.7	7.6	6.3
5/6/2002	0300	60	0.0	6.1	7.8	7.8	7.7	7.7	6.3	7.9	6.2	7.8	6.4	7.7	6.2	6.4	7.4	6.3	7.9	7.7	7.6	6.1
5/6/2002	0400	60	0.0	6.1	7.8	7.8	7.7	7.7	6.3	7.9	6.2	7.8	6.4	7.7	6.2	6.4	7.4	6.3	8.0	7.7	7.6	6.1
5/6/2002	0500	60	0.0	6.1	7.8	7.8	7.7	7.7	6.3	7.9	6.2	7.8	6.4	7.7	6.2	6.4	7.4	6.3	8.0	7.7	7.6	6.1
5/6/2002	0600	60	0.0	6.1	9.3	9.2	7.7	7.7	7.8	7.9	7.6	7.8	8.0	7.7	7.7	8.0	7.9	7.8	7.9	7.7	9.0	7.7

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
5/7/2002	1900	60	0.0	6.1	7.7	7.7	7.7	7.7	7.8	7.9	7.6	7.8	6.4	7.7	6.2	7.9	7.3	7.9	7.9	7.6	7.5	6.0
5/7/2002	2000	60	0.0	6.1	7.7	7.7	7.7	7.7	7.8	7.9	7.6	7.8	6.4	7.7	6.2	7.9	7.3	7.9	7.9	7.6	7.5	6.0
5/7/2002	2100	60	0.0	6.1	9.2	9.3	7.7	7.7	7.8	7.9	7.6	7.9	7.9	7.8	7.7	7.9	7.4	7.9	7.9	7.6	9.0	7.6
5/7/2002	2200	60	0.0	6.2	9.2	9.3	7.8	7.7	7.8	8.0	7.6	7.9	7.9	7.8	7.7	8.0	7.4	7.9	7.9	7.6	9.0	7.6
5/7/2002	2300	60	0.0	6.2	9.2	9.3	7.8	7.7	7.8	8.0	7.6	7.9	7.9	7.8	7.7	8.0	7.4	7.9	7.9	7.6	9.0	7.6
5/8/2002	0000	60	0.0	6.2	9.2	9.3	7.8	7.7	7.8	8.0	7.6	7.9	7.9	7.8	7.7	8.0	7.4	7.9	7.9	7.6	9.0	7.6
5/8/2002	0100	60	0.0	6.2	9.2	9.3	7.8	7.7	7.8	8.0	7.6	7.9	7.9	7.8	7.7	8.0	7.4	7.9	7.9	7.6	9.0	7.6
5/8/2002	0200	60	0.0	6.2	7.8	7.8	7.8	7.7	6.3	8.0	6.1	7.9	6.3	7.8	6.2	6.4	7.4	7.9	7.9	6.2	7.5	6.3
5/8/2002	0300	60	0.0	6.2	7.8	7.8	7.8	7.7	6.3	8.0	6.1	7.9	6.3	7.8	6.2	6.4	7.4	7.9	7.9	6.2	7.5	6.3
5/8/2002	0400	60	0.0	6.2	7.8	7.8	7.8	7.7	6.3	8.0	6.1	7.9	6.3	7.8	6.2	6.4	7.4	7.9	7.9	6.2	7.5	6.3
5/8/2002	0500	60	0.0	6.2	7.8	7.8	7.8	7.7	6.3	8.0	6.1	7.9	6.3	7.8	6.2	6.4	7.4	7.9	7.9	6.2	7.5	6.3
5/8/2002	0600	60	0.0	6.2	7.8	7.8	7.8	7.7	6.3	8.0	6.1	7.9	6.3	7.8	6.2	6.4	7.4	7.9	7.9	6.2	7.5	6.3
5/9/2002	1900	30	0.0	6.2	4.7	4.6	4.7	4.6	4.7	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/9/2002	2000	30	0.0	6.2	4.7	4.6	4.7	4.5	4.7	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/9/2002	2100	30	0.0	6.2	4.7	4.6	4.7	4.5	4.7	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.0	3.2	1.6	0.0	0.0	0.0
5/9/2002	2200	30	0.0	6.2	4.7	4.6	4.7	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/9/2002	2300	30	0.0	6.2	4.7	4.6	4.7	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/10/2002	0000	30	0.0	6.2	4.7	4.6	4.7	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/10/2002	0100	30	0.0	6.2	4.7	4.6	4.7	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/10/2002	0200	30	0.0	6.2	4.7	4.6	4.7	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/10/2002	0300	30	0.0	6.2	4.7	4.6	4.7	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/10/2002	0400	30	0.0	6.2	4.7	4.6	4.7	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/10/2002	0500	30	0.0	6.2	4.7	4.6	4.7	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	2.6	3.2	1.6	0.0	0.0	0.0
5/10/2002	0600	30	0.0	5.9	6.2	6.2	6.2	4.6	4.8	4.7	3.0	3.2	3.2	3.0	3.1	3.2	3.0	3.2	1.6	0.0	0.0	0.0
5/11/2002	1900	30	0.0	4.8	4.8	4.7	4.7	4.7	3.1	3.1	3.0	3.2	3.2	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/11/2002	2000	30	0.0	4.8	4.8	4.7	4.7	4.7	4.7	3.1	3.0	3.2	3.2	3.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/11/2002	2100	30	0.0	4.8	4.8	4.7	4.7	4.7	4.7	4.8	3.0	3.2	3.2	3.0	3.3	3.2	1.6	0.0	0.0	0.0	0.0	0.0

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
5/11/2002	2200	30	0.0	4.8	4.8	4.7	4.7	4.7	4.7	4.8	3.1	3.2	3.2	3.0	3.3	3.2	1.6	0.0	0.0	0.0	0.0	0.0
5/11/2002	2300	30	0.0	4.8	4.8	4.4	4.7	4.7	4.7	4.5	3.1	3.2	3.2	3.0	3.2	3.2	0.0	0.0	0.0	0.0	0.0	0.0
5/12/2002	0000	30	0.0	4.8	4.8	4.5	4.7	4.7	4.7	3.2	3.1	3.2	3.2	3.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/12/2002	0100	30	0.0	4.8	4.8	4.5	4.7	4.7	4.7	3.2	3.1	3.2	3.2	3.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/12/2002	0200	30	0.0	4.8	4.8	4.4	4.7	4.7	4.7	3.2	3.1	3.2	3.2	3.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/12/2002	0300	30	0.0	4.8	4.8	4.4	4.7	4.7	4.7	3.2	3.1	3.2	3.2	3.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/12/2002	0400	30	0.0	4.8	4.8	4.5	4.7	4.7	4.7	3.2	3.1	3.2	3.2	3.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/12/2002	0500	30	0.0	4.8	6.2	5.0	4.7	4.7	4.7	3.2	3.1	3.2	3.2	3.0	3.7	1.6	0.0	0.0	0.0	0.0	0.0	0.0
5/12/2002	0600	30	0.0	4.8	6.2	5.0	4.7	4.7	4.7	3.2	3.1	3.2	3.2	3.0	3.7	3.2	2.7	1.6	0.0	0.0	0.0	0.0
5/13/2002	1900	60	0.0	6.4	7.9	8.1	8.1	8.0	6.4	7.9	6.5	7.9	6.4	7.9	6.4	6.4	7.9	6.3	8.0	7.9	7.9	6.5
5/13/2002	2000	60	0.0	6.4	7.9	8.1	8.1	8.0	6.4	7.9	6.5	7.9	6.4	7.9	6.4	6.4	7.9	6.3	8.0	7.9	7.9	6.5
5/13/2002	2100	60	0.0	6.4	7.8	8.1	8.1	8.0	6.4	7.9	6.5	7.9	6.4	7.8	6.4	6.4	7.9	6.3	8.0	7.9	7.9	6.5
5/13/2002	2200	60	0.0	6.4	7.8	8.1	8.1	8.0	6.4	7.9	6.5	7.9	6.4	7.8	6.4	6.4	7.9	6.3	8.0	7.9	7.9	6.5
5/13/2002	2300	60	0.0	6.4	6.2	6.2	6.2	6.0	6.4	6.3	6.3	6.3	4.9	6.2	4.7	6.4	6.3	6.3	6.4	6.2	6.0	4.6
5/14/2002	0000	60	0.0	6.4	6.2	6.2	6.2	6.0	6.4	6.3	6.3	6.3	4.9	6.2	4.7	6.4	6.3	6.3	6.4	6.2	6.0	4.6
5/14/2002	0100	60	0.0	6.4	6.2	6.2	6.2	6.0	6.4	6.3	6.3	6.3	4.9	6.2	4.7	6.4	6.3	6.3	6.4	6.2	6.0	4.6
5/14/2002	0200	60	0.0	6.4	6.2	6.2	6.2	4.7	4.8	6.3	4.6	6.3	4.9	6.2	4.7	4.8	6.3	4.8	6.4	4.6	6.0	4.6
5/14/2002	0300	60	0.0	6.4	6.2	6.2	6.2	4.7	4.8	6.3	4.6	6.3	4.9	6.2	4.7	4.8	6.3	4.8	6.4	4.6	6.0	4.6
5/14/2002	0400	60	0.0	6.4	6.2	6.2	6.2	4.7	4.8	6.3	4.6	6.3	4.9	6.2	4.7	4.8	6.3	4.8	6.4	4.6	6.0	4.6
5/14/2002	0500	60	0.0	6.4	6.2	6.2	6.2	6.1	6.2	6.3	6.1	6.3	6.4	6.2	4.7	6.4	6.3	6.3	6.4	6.0	6.0	4.6
5/14/2002	0600	60	0.0	6.4	7.8	7.7	7.8	6.1	6.2	7.9	6.1	7.8	6.4	6.2	6.2	6.4	7.3	6.3	8.0	6.0	7.5	6.1
5/15/2002	1900	60	0.0	6.1	7.7	7.7	7.8	6.1	6.3	7.9	6.1	7.8	6.4	7.8	6.2	6.4	7.4	6.4	8.0	6.0	7.6	6.1
5/15/2002	2000	60	0.0	6.1	7.7	7.7	7.8	6.1	6.3	7.9	6.1	7.8	6.4	7.8	6.2	6.4	7.4	6.4	8.0	6.0	7.6	6.1
5/15/2002	2100	60	0.0	7.7	7.7	7.7	7.8	7.7	7.8	7.8	7.6	7.8	7.9	7.8	6.3	7.9	7.4	7.9	8.0	7.7	7.6	6.1
5/15/2002	2200	60	0.0	7.7	7.7	7.7	7.8	7.7	7.9	7.9	7.6	7.8	7.9	7.8	6.3	8.0	7.4	8.0	8.0	7.7	7.6	6.1
5/15/2002	2300	60	0.0	7.7	7.7	7.7	7.8	7.7	7.9	7.9	7.6	7.8	7.9	7.8	6.3	8.0	7.4	8.0	8.0	7.7	7.6	6.1
5/16/2002	0000	60	0.0	7.7	7.7	7.7	7.8	7.7	7.9	7.9	7.6	7.8	7.9	7.8	6.3	8.0	7.4	8.0	8.0	7.7	7.6	6.1

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
5/16/2002	0100	60	0.0	7.7	7.7	7.7	7.8	7.7	7.9	7.9	7.6	7.8	7.9	7.8	6.3	8.0	7.4	8.0	8.0	7.7	7.6	6.1
5/16/2002	0200	60	0.0	6.2	7.7	7.7	7.8	6.1	6.3	7.9	6.1	7.8	6.3	7.8	6.3	6.4	7.4	6.3	8.0	6.1	7.6	6.1
5/16/2002	0300	60	0.0	6.2	7.7	7.7	6.2	6.1	6.3	6.3	6.1	6.3	6.3	6.2	6.3	6.4	7.7	6.3	8.0	6.1	7.6	6.1
5/16/2002	0400	60	0.0	6.2	7.7	7.7	6.2	6.1	6.3	6.3	6.1	6.3	6.3	6.2	6.3	6.4	7.7	6.3	8.0	6.1	7.6	6.1
5/16/2002	0500	60	0.0	6.2	7.7	7.7	6.2	6.1	6.3	6.3	6.1	6.3	6.3	6.2	6.3	6.4	7.7	6.3	8.0	6.1	7.6	6.1
5/16/2002	0600	60	0.0	6.2	7.7	7.7	6.2	6.1	6.3	6.3	6.1	6.3	6.3	6.2	6.3	6.4	7.7	6.3	8.0	6.1	7.6	6.1
5/17/2002	1900	30	0.0	4.7	4.7	4.6	4.7	4.6	4.7	4.8	3.0	3.1	3.2	3.1	3.2	3.2	3.3	3.2	0.0	0.0	0.0	0.0
5/17/2002	2000	30	0.0	4.7	4.7	4.6	4.7	4.6	4.7	4.8	3.0	3.1	3.2	3.1	3.2	3.2	3.3	3.2	0.0	0.0	0.0	0.0
5/17/2002	2100	30	0.0	6.1	6.2	6.2	4.6	4.6	4.7	4.8	3.0	3.1	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/17/2002	2200	30	0.0	6.1	6.2	6.2	4.7	4.6	4.7	4.8	3.0	3.1	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/17/2002	2300	30	0.0	6.1	6.2	6.2	4.7	4.6	4.7	4.8	3.0	3.1	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/18/2002	0000	30	0.0	6.1	6.2	6.2	4.7	4.6	4.7	4.8	3.0	3.1	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/18/2002	0100	30	0.0	6.1	6.2	6.2	4.7	4.6	4.7	4.8	3.0	3.1	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/18/2002	0200	30	0.0	6.1	6.2	6.2	6.2	4.6	4.7	4.8	4.7	4.8	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/18/2002	0300	30	0.0	6.1	6.2	6.2	6.2	4.6	4.7	4.8	4.7	4.8	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/18/2002	0400	30	0.0	6.1	6.2	6.2	6.2	4.6	4.7	4.8	4.7	4.8	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/18/2002	0500	30	0.0	6.1	6.2	6.2	6.2	4.6	4.7	4.8	4.7	4.8	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/18/2002	0600	30	0.0	6.1	6.2	6.2	6.2	4.6	4.7	4.8	4.7	4.8	3.2	3.1	3.2	3.2	3.3	3.2	1.6	0.0	0.0	0.0
5/19/2002	1900	30	0.0	6.3	7.8	6.2	6.2	6.3	4.7	4.7	4.6	4.7	3.2	3.1	3.3	3.2	3.0	3.2	1.6	0.0	0.0	0.0
5/19/2002	2000	30	0.0	6.3	7.7	6.2	6.2	6.3	4.6	4.6	4.6	4.7	3.2	3.1	3.3	3.2	3.1	3.2	3.3	1.4	0.0	0.0
5/19/2002	2100	30	0.0	6.3	7.7	6.1	6.2	6.3	4.6	4.6	4.6	4.7	3.2	3.1	3.3	3.2	3.1	3.2	3.3	1.4	0.0	0.0
5/19/2002	2200	30	0.0	6.3	7.8	7.8	6.2	6.3	6.2	4.7	4.6	4.7	4.8	4.7	4.7	4.8	3.1	3.2	3.3	1.4	0.0	0.0
5/19/2002	2300	30	0.0	6.4	7.8	7.9	6.2	6.3	5.0	4.8	4.6	4.7	4.8	4.7	3.2	3.2	3.1	3.3	3.3	1.6	0.0	0.0
5/20/2002	0000	30	0.0	6.4	7.8	7.9	6.2	6.3	5.0	4.8	4.6	4.7	4.8	4.7	3.2	3.2	3.1	3.3	3.0	1.3	0.0	0.0
5/20/2002	0100	30	0.0	6.4	7.8	6.2	6.2	6.3	4.8	4.8	4.6	4.7	3.2	3.1	3.2	3.2	3.1	3.3	1.6	0.0	0.0	0.0
5/20/2002	0200	30	0.0	6.4	7.8	6.2	6.2	6.3	4.8	4.8	4.6	4.7	3.2	3.1	3.2	3.2	3.1	3.3	1.6	0.0	0.0	0.0
5/20/2002	0300	30	0.0	6.4	7.8	6.2	6.2	6.3	4.8	4.8	4.6	4.7	3.2	3.1	3.2	3.2	3.1	3.3	1.6	0.0	0.0	0.0

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
5/20/2002	0400	30	0.0	6.4	7.8	6.2	6.2	6.3	4.8	4.8	4.6	4.7	3.2	3.1	3.2	3.2	3.1	3.3	1.6	0.0	0.0	0.0
5/20/2002	0500	30	0.0	6.4	7.8	6.2	6.2	6.3	4.8	4.8	4.6	4.7	3.2	3.1	3.2	3.2	3.1	3.3	1.6	0.0	0.0	0.0
5/20/2002	0600	30	0.0	6.4	7.8	6.2	6.2	6.3	4.8	4.8	4.6	4.7	3.2	3.1	3.2	3.2	3.1	3.3	1.6	0.0	0.0	0.0
5/21/2002	1900	60	0.0	6.2	9.4	9.2	9.2	7.7	7.8	9.2	7.7	7.8	7.9	7.8	7.7	7.9	8.8	7.8	9.4	7.6	9.0	7.6
5/21/2002	2000	60	0.0	6.3	9.5	9.4	8.0	7.8	7.8	7.8	7.7	7.8	7.9	7.8	7.8	7.9	9.4	7.8	9.4	7.9	9.4	7.8
5/21/2002	2100	60	0.0	6.3	9.5	9.4	8.0	7.8	7.8	7.8	7.7	7.8	7.9	7.8	7.8	7.9	9.4	7.8	9.4	7.9	9.4	7.8
5/21/2002	2200	60	0.0	6.3	9.5	9.4	8.0	7.8	7.8	7.8	7.7	7.8	7.9	7.8	7.9	8.0	9.5	7.9	9.4	7.9	9.4	7.9
5/21/2002	2300	60	0.0	6.3	9.5	9.4	8.0	7.8	7.8	7.8	7.7	7.8	7.9	7.8	7.9	8.0	9.5	7.9	9.4	7.9	9.4	7.9
5/22/2002	0000	60	0.0	6.3	9.5	9.4	8.0	7.8	7.8	7.8	7.7	7.8	7.9	7.8	7.9	8.0	9.5	7.9	9.4	7.9	9.4	7.9
5/22/2002	0100	60	0.0	6.3	9.5	9.4	8.0	7.8	7.8	7.8	7.7	7.8	7.9	7.8	7.9	8.0	9.5	7.9	9.4	7.9	9.4	7.9
5/22/2002	0200	60	0.0	6.3	9.5	9.4	8.0	7.8	7.8	7.8	7.7	7.8	7.9	7.8	7.9	8.0	9.5	7.9	9.4	7.9	9.4	7.9
5/22/2002	0300	60	0.0	6.3	9.5	9.4	8.0	7.8	7.8	7.8	7.7	7.8	7.9	7.8	7.9	8.0	9.5	7.9	9.4	7.9	9.4	7.9
5/22/2002	0400	60	0.0	6.3	6.3	6.2	5.4	5.3	4.0	4.0	3.9	4.1	4.2	4.0	4.1	4.8	5.7	4.2	5.8	4.2	5.5	4.4
5/22/2002	0500	60	0.0	6.3	9.3	9.3	7.8	7.9	7.8	7.9	7.8	7.8	7.9	7.8	8.1	8.0	9.4	8.0	9.4	7.9	9.4	7.9
5/22/2002	0600	60	0.0	6.3	9.3	9.3	7.8	7.9	7.8	7.9	7.8	7.8	7.9	7.8	8.1	8.0	9.4	8.0	9.4	7.9	9.5	7.9
5/23/2002	1900	60	0.0	6.1	9.1	9.2	9.2	7.6	7.8	9.4	7.7	7.8	7.8	7.7	7.7	7.9	8.8	7.8	9.4	7.6	8.9	7.6
5/23/2002	2000	60	0.0	6.1	9.2	9.2	9.2	7.6	7.8	9.4	7.7	7.8	7.8	7.7	7.7	7.9	8.8	7.8	9.5	7.6	8.9	7.6
5/23/2002	2100	60	0.0	6.1	9.2	9.2	9.2	7.6	7.8	9.4	7.7	7.8	7.8	7.7	7.7	7.9	8.8	7.8	9.5	7.6	8.9	7.6
5/23/2002	2200	60	0.0	6.1	9.2	9.3	9.3	7.6	7.9	9.4	7.7	7.9	7.9	7.7	7.7	7.9	8.8	7.8	9.5	7.6	8.9	7.6
5/23/2002	2300	60	0.0	6.1	9.2	9.3	9.3	7.6	7.9	9.4	7.7	7.9	7.9	7.8	7.7	7.9	8.9	7.8	9.5	7.7	8.9	7.7
5/24/2002	0000	60	0.0	6.1	9.2	9.3	9.3	7.6	7.9	9.5	7.7	7.9	7.9	7.8	7.7	8.0	8.9	7.9	9.5	7.7	9.0	7.7
5/24/2002	0100	60	0.0	6.1	9.2	9.3	9.3	7.6	7.9	9.5	7.7	7.9	7.9	7.8	7.7	8.0	8.9	7.9	9.5	7.7	9.1	7.7
5/24/2002	0200	60	0.0	6.3	9.2	9.3	7.7	7.6	7.9	7.8	7.7	7.9	7.9	7.8	7.7	8.0	7.9	7.9	7.9	7.9	7.9	7.9
5/24/2002	0300	60	0.0	6.3	9.3	9.3	7.7	7.6	7.9	7.8	7.7	7.9	7.9	7.8	7.7	8.0	7.9	7.9	7.9	7.9	7.9	7.9
5/24/2002	0400	60	0.0	6.3	9.3	9.3	7.7	7.6	7.9	7.8	7.7	7.9	7.9	7.8	7.7	8.0	7.9	7.9	7.9	7.9	7.9	7.9
5/24/2002	0500	60	0.0	6.3	9.3	9.3	9.3	7.6	7.9	7.9	7.7	7.9	8.0	7.8	7.7	8.0	8.9	7.9	9.5	7.9	9.0	7.9
5/24/2002	0600	60	0.0	6.3	9.3	9.3	9.3	7.6	7.9	7.9	7.7	7.9	8.0	7.8	7.7	8.0	8.9	7.9	9.5	7.9	9.0	7.9

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
5/25/2002	1900	30	0.0	6.0	6.3	6.2	6.3	4.7	4.7	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/25/2002	2000	30	0.0	6.0	6.2	6.2	6.3	4.7	4.7	4.8	3.1	3.2	3.0	3.0	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/25/2002	2100	30	0.0	6.0	6.2	6.2	6.3	4.7	4.7	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/25/2002	2200	30	0.0	6.0	6.2	6.2	6.3	4.7	4.7	4.8	3.1	3.2	3.0	3.0	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/25/2002	2300	30	0.0	6.0	6.3	4.6	4.7	4.7	4.7	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/26/2002	0000	30	0.0	6.0	6.3	4.6	4.7	4.7	4.7	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/26/2002	0100	30	0.0	6.0	6.3	4.6	4.7	4.7	4.7	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/26/2002	0200	30	0.0	6.0	6.3	4.6	4.7	4.7	4.7	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/26/2002	0300	30	0.0	6.0	6.3	4.6	4.7	4.7	4.7	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/26/2002	0400	30	0.0	6.0	6.3	4.6	4.7	4.7	4.8	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/26/2002	0500	30	0.0	6.0	6.3	4.6	4.7	4.7	4.8	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/26/2002	0600	30	0.0	6.0	6.3	4.6	4.7	4.7	4.8	4.8	3.1	3.2	3.0	3.1	3.5	3.2	3.2	3.1	1.6	0.0	0.0	0.0
5/27/2002	1900	30	0.0	6.3	7.8	7.7	6.2	6.1	6.3	4.7	4.7	4.8	4.8	4.7	4.6	3.2	4.3	4.8	3.2	1.4	0.0	0.0
5/27/2002	2000	30	0.0	6.3	7.8	6.2	6.2	6.1	4.8	4.7	4.7	4.8	4.8	4.7	4.6	3.2	4.3	4.8	3.2	1.4	0.0	0.0
5/27/2002	2100	30	0.0	6.3	7.8	6.2	6.2	6.1	4.8	4.7	4.7	4.8	4.8	4.7	4.6	3.2	4.3	4.8	3.2	1.4	0.0	0.0
5/27/2002	2200	30	0.0	6.3	7.8	6.2	6.2	6.1	4.8	4.7	4.7	4.8	4.8	4.7	4.6	3.2	4.3	4.8	3.2	1.4	0.0	0.0
5/27/2002	2300	30	0.0	6.3	7.8	6.2	6.2	6.1	4.8	4.7	4.8	4.8	3.2	3.2	3.2	3.2	3.3	3.2	3.3	1.4	0.0	0.0
5/28/2002	0000	30	0.0	6.3	7.8	6.2	6.2	6.1	4.8	4.7	4.8	4.8	3.2	3.2	3.2	3.2	3.3	3.2	3.3	1.4	0.0	0.0
5/28/2002	0100	30	0.0	6.3	7.8	6.2	6.2	6.1	4.8	4.7	4.8	4.8	3.2	3.0	3.2	3.2	3.3	3.2	3.3	1.4	0.0	0.0
5/28/2002	0200	30	0.0	6.3	7.8	7.7	6.2	6.1	6.3	4.7	4.8	4.8	4.8	4.6	4.6	3.2	3.3	3.2	3.3	1.4	0.0	0.0
5/28/2002	0300	30	0.0	6.3	7.8	7.7	6.2	6.1	6.3	4.7	4.8	4.8	4.8	4.6	4.6	3.2	3.3	3.2	3.3	1.4	0.0	0.0
5/28/2002	0400	30	0.0	6.3	7.8	7.7	6.2	6.1	6.3	4.7	4.8	4.8	4.8	4.6	4.6	3.2	3.3	3.2	3.3	1.4	0.0	0.0
5/28/2002	0500	30	0.0	6.3	7.8	7.7	6.2	6.1	6.3	4.7	4.8	4.8	4.8	4.6	4.6	3.2	3.3	3.2	3.3	1.4	0.0	0.0
5/28/2002	0600	30	0.0	6.3	7.8	7.7	6.2	6.1	6.3	4.7	4.8	4.8	4.8	4.6	4.6	3.2	3.3	3.2	3.3	1.4	0.0	0.0
5/29/2002	1900	60	0.0	6.1	9.2	9.0	9.3	7.6	7.8	9.4	7.6	6.5	8.0	7.8	7.7	7.9	9.3	7.9	9.5	7.6	9.0	7.6
5/29/2002	2000	60	0.0	6.1	9.2	9.1	9.3	7.6	7.8	9.4	7.6	6.5	8.0	7.8	7.7	7.9	9.3	7.9	9.5	7.6	9.0	7.6
5/29/2002	2100	60	0.0	6.1	9.2	9.1	9.3	7.6	7.8	9.4	7.6	6.5	8.0	7.8	7.7	7.9	9.3	7.9	9.5	7.6	9.0	7.6

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
5/29/2002	2200	60	0.0	6.1	9.2	9.0	9.3	7.6	7.8	9.4	7.6	6.4	8.0	7.8	7.7	7.9	9.3	7.9	9.5	7.6	9.0	7.6
5/29/2002	2300	60	0.0	6.1	9.2	9.1	9.3	7.6	7.8	9.4	7.6	6.5	8.0	7.8	7.7	7.9	9.3	7.9	9.5	7.6	9.0	7.6
5/30/2002	0000	60	0.0	6.1	9.2	9.1	9.3	7.7	7.9	9.4	7.7	6.5	8.0	7.8	7.7	7.9	9.3	7.9	9.5	7.6	9.0	7.6
5/30/2002	0100	60	0.0	6.1	9.2	9.1	9.3	7.7	7.9	9.4	7.7	6.5	8.0	7.8	7.7	7.9	9.3	7.9	9.5	7.6	9.0	7.6
5/30/2002	0200	60	0.0	6.1	9.2	9.1	9.3	7.7	7.9	9.4	7.7	6.5	8.0	7.8	7.7	7.9	9.3	7.9	9.5	7.6	9.0	7.6
5/30/2002	0300	60	0.0	6.1	9.2	9.1	9.3	7.7	7.9	9.4	7.7	6.5	8.0	7.8	7.7	8.0	9.3	8.0	9.5	7.6	9.0	7.6
5/30/2002	0400	60	0.0	6.1	9.2	9.1	9.3	7.7	7.9	9.4	7.7	6.5	8.0	7.8	7.7	8.0	9.3	8.0	9.5	7.6	9.1	7.6
5/30/2002	0500	60	0.0	6.1	9.2	9.1	9.3	7.7	7.9	9.4	7.7	6.5	8.0	7.8	7.7	8.0	9.3	8.0	9.5	7.6	9.1	7.6
5/30/2002	0600	60	0.0	6.1	9.2	9.1	9.3	7.7	7.9	9.4	7.7	6.5	8.0	7.8	7.7	8.0	9.3	8.0	9.5	7.6	9.1	7.6
6/29/2002	1900	60	0.0	6.1	9.2	9.2	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/29/2002	2000	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/29/2002	2100	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/29/2002	2200	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/29/2002	2300	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/29/2002	0000	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/30/2002	0100	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/30/2002	0200	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/30/2002	0300	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/30/2002	0400	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/30/2002	0500	60	0.0	6.1	9.2	9.3	7.7	7.8	7.9	7.9	7.7	7.9	8.0	7.9	7.8	8.0	7.4	8.0	8.0	7.7	9.1	7.6
6/30/2002	0600	60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/1/2002	1900	30	0.0	6.5	7.7	7.7	6.2	6.2	6.3	6.4	4.6	4.8	4.8	4.7	4.7	4.8	4.3	4.8	3.3	1.5	0.0	0.0
7/1/2002	2000	30	0.0	6.5	7.7	7.7	6.2	6.2	6.3	6.4	4.6	3.0	4.8	4.7	4.7	4.8	4.3	4.8	3.3	1.5	0.0	0.0
7/1/2002	2100	30	0.0	6.5	7.7	7.7	6.2	6.2	6.3	6.4	4.6	3.0	4.8	4.7	4.7	4.8	4.3	4.8	3.3	1.5	0.0	0.0
7/1/2002	2200	30	0.0	6.5	7.7	7.7	6.2	6.2	6.3	6.4	4.6	3.0	4.8	4.7	4.7	4.8	4.3	4.8	3.3	1.5	0.0	0.0
7/1/2002	2300	30	0.0	6.5	7.7	7.7	6.2	6.2	6.3	6.4	4.6	3.0	4.8	4.7	4.7	4.8	4.3	4.8	3.3	1.5	0.0	0.0
7/2/2002	0000	30	0.0	6.5	7.7	7.7	6.2	6.2	6.3	6.4	4.6	3.0	4.8	4.7	4.7	4.8	4.3	4.8	3.3	1.5	0.0	0.0

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
7/2/2002	0100	30	0.0	6.5	7.7	7.7	6.2	6.2	6.3	6.4	4.6	3.0	4.8	4.7	4.7	4.8	4.3	4.8	3.3	1.5	0.0	0.0
7/2/2002	0200	30	0.0	6.5	7.7	7.7	6.2	6.2	6.3	6.4	4.6	3.0	4.8	4.7	4.7	4.8	4.3	4.8	3.3	1.5	0.0	0.0
7/2/2002	0300	30	0.0	6.3	9.3	10.8	10.8	9.3	9.3	10.9	9.1	10.8	9.4	9.4	9.4	9.5	10.9	9.3	11.0	9.2	10.8	9.2
7/2/2002	0400	30	0.0	6.3	9.3	10.8	10.8	9.3	9.3	10.9	9.1	10.8	9.4	9.2	9.4	9.5	10.9	9.3	11.0	9.2	10.8	9.2
7/2/2002	0500	30	0.0	6.3	9.3	10.8	10.8	9.3	9.3	10.9	9.1	10.8	9.4	9.2	9.4	9.5	10.9	9.3	11.0	9.2	10.8	9.2
7/2/2002	0600	30	0.0	6.3	7.8	7.8	6.2	6.2	6.4	6.3	4.6	4.8	4.8	4.6	4.7	4.8	4.7	4.8	4.9	0.0	0.0	0.0
7/9/2002	1900	60	0.0	6.5	9.2	8.0	7.9	7.6	7.8	8.0	7.7	7.9	7.9	7.8	7.9	7.9	7.9	7.9	7.9	7.8	7.9	7.8
7/9/2002	2000	60	0.0	6.5	9.2	7.9	7.8	7.6	7.8	7.9	7.7	7.9	7.9	7.8	7.8	7.9	7.9	7.8	7.9	7.8	7.9	7.8
7/9/2002	2100	60	0.0	6.5	7.8	7.9	7.8	7.6	6.4	8.0	6.2	7.9	6.3	7.8	6.3	6.3	7.9	6.3	7.9	7.8	7.9	7.8
7/9/2002	2200	60	0.0	6.5	6.3	6.3	6.2	6.2	4.8	6.4	4.6	6.3	4.9	6.2	4.7	4.8	6.3	4.7	6.4	6.2	6.1	4.7
7/9/2002	2300	60	0.0	6.5	6.3	6.3	6.2	6.2	4.8	6.4	4.6	6.3	4.9	6.2	4.7	4.8	6.3	4.7	6.4	6.2	6.1	4.7
7/10/2002	0000	60	0.0	6.5	6.3	6.3	6.2	6.2	4.8	6.4	4.6	6.3	4.9	6.2	4.7	4.8	6.3	4.7	6.4	6.2	6.1	4.7
7/10/2002	0100	60	0.0	6.6	6.2	6.2	6.2	6.2	4.8	6.3	4.6	6.3	4.9	6.2	4.7	4.8	6.3	4.7	6.4	6.1	6.0	4.7
7/10/2002	0200	60	0.0	6.6	7.7	7.8	6.2	6.2	6.3	6.4	4.6	4.8	4.9	4.6	4.7	4.8	4.7	4.7	3.3	1.6	0.0	0.0
7/10/2002	0300	60	0.0	6.6	7.7	7.8	6.2	6.2	6.3	6.4	4.6	4.8	4.9	4.7	4.7	4.8	4.7	4.7	3.3	1.6	0.0	0.0
7/10/2002	0400	60	0.0	6.6	7.7	7.8	6.2	6.2	6.3	6.4	4.6	4.8	4.9	4.7	4.7	4.8	4.7	4.7	3.3	1.6	0.0	0.0
7/10/2002	0500	60	0.0	6.6	7.7	7.8	6.2	6.2	6.3	6.4	4.6	4.8	4.9	4.7	4.7	4.8	4.7	4.7	3.3	1.6	0.0	0.0
7/10/2002	0600	60	0.0	4.5	4.7	3.2	3.2	3.1	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/11/2002	1900	60	0.0	6.1	9.3	9.2	9.3	7.7	7.9	9.4	7.7	9.4	7.9	9.3	7.7	8.0	8.9	7.9	9.4	7.6	9.0	7.6
7/11/2002	2000	60	0.0	6.1	9.3	9.2	9.3	7.7	7.9	9.4	7.7	9.4	7.9	9.3	7.7	7.9	8.9	7.9	9.4	7.6	9.0	7.6
7/11/2002	2100	60	0.0	6.1	9.3	9.2	9.3	7.7	7.9	9.4	7.7	9.4	7.9	9.3	7.7	7.9	8.9	7.9	9.4	7.6	9.0	7.6
7/11/2002	2200	60	0.0	6.1	9.3	9.2	9.3	7.7	7.9	9.4	7.6	9.4	7.9	9.3	7.7	7.9	8.8	7.9	9.4	7.6	9.0	7.6
7/11/2002	2300	60	0.0	6.1	9.3	9.2	9.3	7.7	7.9	9.4	7.7	9.4	7.9	9.3	7.7	7.9	8.9	7.9	9.4	7.6	9.0	7.6
7/12/2002	0000	60	0.0	6.1	7.9	7.8	7.8	7.7	7.9	7.9	7.7	7.9	7.9	7.8	7.7	8.0	7.8	7.9	7.9	7.6	7.6	6.3
7/12/2002	0100	60	0.0	6.1	7.9	6.3	6.2	6.1	6.3	6.3	6.2	6.3	6.4	6.2	6.2	6.4	6.3	6.3	6.3	6.2	6.0	6.3
7/12/2002	0200	60	0.0	6.1	7.9	7.7	7.7	6.1	6.3	6.3	6.2	4.8	4.9	4.6	4.7	4.8	4.7	4.7	3.3	3.1	0.0	0.0
7/12/2002	0300	60	0.0	6.1	7.9	7.7	7.7	6.1	6.3	6.3	6.2	4.8	4.9	4.6	4.7	4.8	4.7	4.7	3.3	3.1	0.0	0.0

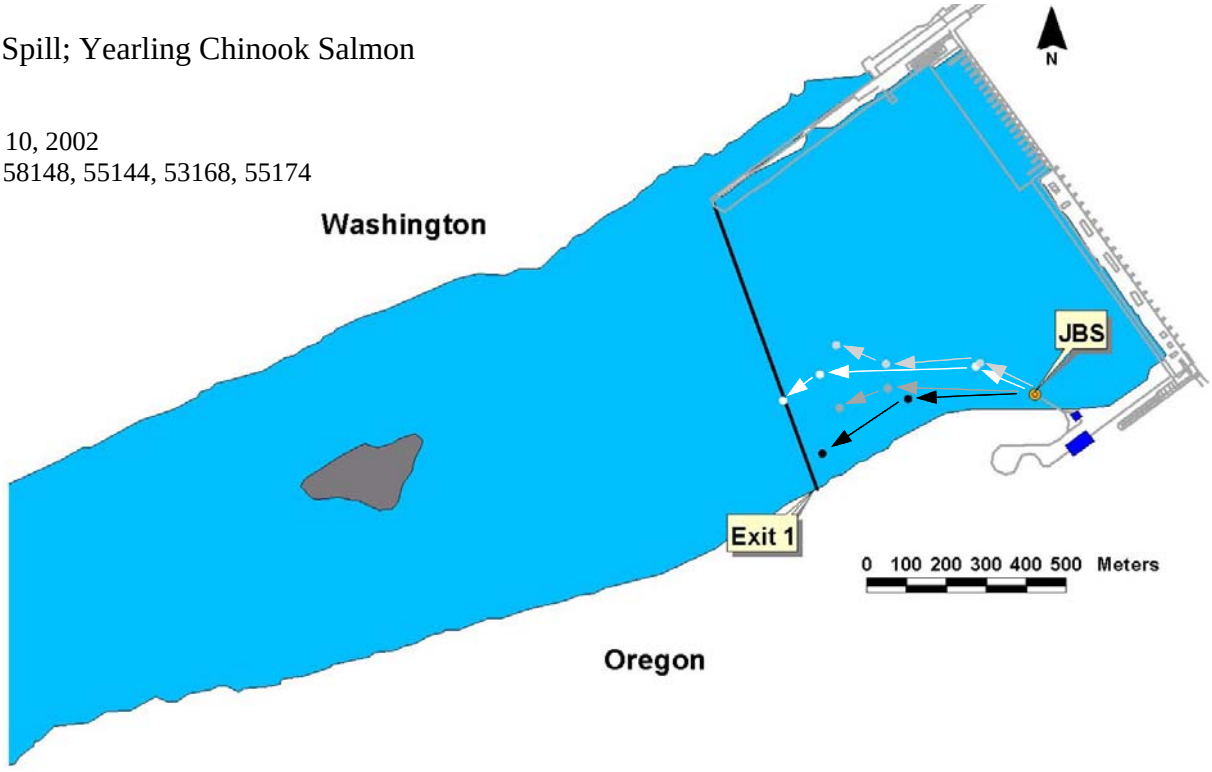
Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
7/12/2002	0400	60	0.0	6.1	7.9	7.7	7.7	6.1	6.3	6.3	6.2	4.8	4.9	4.6	4.7	4.8	4.7	4.7	3.3	3.1	0.0	0.0
7/12/2002	0500	60	0.0	6.1	7.9	7.7	7.7	6.1	6.3	6.3	6.2	4.8	4.9	4.6	4.7	4.8	4.7	4.7	3.3	3.1	0.0	0.0
7/12/2002	0600	60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/13/2002	1900	30	0.0	6.2	7.7	7.7	6.2	6.1	6.3	6.3	6.0	4.7	4.8	4.6	4.7	4.8	4.2	4.8	3.3	1.6	0.0	0.0
7/13/2002	2000	30	0.0	6.2	7.7	7.7	6.2	6.1	6.3	6.3	6.0	4.7	4.8	4.6	4.7	4.8	4.2	4.8	3.3	1.6	0.0	0.0
7/13/2002	2100	30	0.0	6.2	7.7	7.7	6.2	6.1	6.3	6.3	6.0	4.7	4.8	4.6	4.7	4.8	4.2	4.8	3.3	1.6	0.0	0.0
7/13/2002	2200	30	0.0	6.1	7.7	7.7	6.2	6.1	6.2	4.8	4.6	4.8	4.8	4.6	3.2	3.2	3.2	3.1	3.3	1.5	0.0	0.0
7/13/2002	2300	30	0.0	6.1	7.7	7.7	6.2	6.1	6.2	4.8	4.6	4.8	4.8	4.6	3.1	3.2	3.2	3.1	3.3	1.5	0.0	0.0
7/14/2002	0000	30	0.0	6.1	7.7	7.7	6.2	6.1	6.2	4.8	4.6	4.8	4.8	4.6	3.1	3.2	3.2	3.1	3.3	1.5	0.0	0.0
7/14/2002	0100	30	0.0	6.1	7.7	6.2	6.2	6.1	4.8	4.8	4.6	4.8	3.3	4.6	3.1	3.2	3.2	3.1	3.3	0.0	0.0	0.0
7/14/2002	0200	30	0.0	6.1	6.3	6.2	6.2	4.7	4.8	4.8	4.6	4.8	3.3	4.6	3.1	3.2	3.2	3.1	1.6	0.0	0.0	0.0
7/14/2002	0300	30	0.0	6.1	6.3	6.3	6.2	4.7	4.8	4.8	4.6	4.8	3.3	4.6	3.2	3.2	3.3	3.1	1.6	0.0	0.0	0.0
7/14/2002	0400	30	0.0	6.1	6.3	6.3	4.6	4.7	4.8	4.8	3.0	3.2	3.3	3.1	3.2	3.2	3.3	3.1	1.6	0.0	0.0	0.0
7/14/2002	0500	30	0.0	6.1	6.3	6.3	4.6	4.7	4.8	4.8	3.0	3.2	3.3	3.1	3.2	3.2	3.3	3.1	1.6	0.0	0.0	0.0
7/14/2002	0600	30	0.0	4.7	4.8	4.7	4.7	4.7	4.8	4.8	3.0	3.2	3.3	3.1	3.2	3.2	3.3	1.6	0.0	0.0	0.0	0.0
7/15/2002	1900	60	0.0	6.2	7.8	7.7	7.7	7.7	7.8	7.9	7.7	7.9	8.0	7.7	7.7	7.9	7.4	7.9	7.9	7.6	7.6	6.3
7/15/2002	2000	60	0.0	6.4	9.4	9.3	7.7	7.8	7.8	7.8	7.8	7.8	7.9	7.8	7.8	7.9	9.4	7.9	9.4	7.9	9.4	7.8
7/15/2002	2100	60	0.0	6.4	9.3	9.3	7.7	7.8	7.8	7.8	7.8	7.8	7.9	7.8	7.8	7.9	9.4	7.9	9.4	7.9	9.4	7.8
7/15/2002	2200	60	0.0	6.4	7.8	7.7	7.7	7.8	6.3	7.8	6.1	7.8	6.4	7.8	6.3	6.3	7.8	7.9	7.9	7.9	7.5	6.2
7/15/2002	2300	60	0.0	6.4	6.3	6.2	6.3	6.2	6.3	6.3	6.2	6.3	6.4	6.3	6.4	6.3	6.3	6.3	6.5	6.3	6.3	6.2
7/16/2002	0000	60	0.0	6.4	6.3	6.3	6.3	4.6	4.8	6.3	4.6	6.3	4.8	6.3	4.7	6.4	6.3	4.8	6.4	6.1	6.3	4.7
7/16/2002	0100	60	0.0	6.4	7.8	7.7	7.7	6.1	6.3	6.0	6.1	6.3	4.8	4.7	4.8	4.8	4.7	4.7	3.3	3.1	0.0	0.0
7/16/2002	0200	60	0.0	6.4	7.8	7.7	7.7	6.1	6.3	6.0	6.1	6.3	4.8	4.7	4.8	4.8	4.7	4.7	3.3	3.1	0.0	0.0
7/16/2002	0300	60	0.0	6.4	7.7	7.7	7.7	6.1	6.3	6.0	6.1	6.3	4.8	4.7	4.8	4.8	4.7	4.7	3.3	3.1	0.0	0.0
7/16/2002	0400	60	0.0	6.4	7.8	7.7	7.7	6.1	6.3	6.0	6.1	6.3	4.8	4.7	4.8	4.8	4.7	4.7	3.3	3.1	0.0	0.0
7/16/2002	0500	60	0.0	6.4	7.8	7.7	7.7	6.2	6.3	6.1	6.1	6.3	4.8	4.7	4.8	4.8	4.7	4.7	3.3	3.1	0.0	0.0
7/16/2002	0600	60	0.0	4.7	4.8	3.1	3.1	3.1	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Release Date	Hour	Spill %	SP1 (kcfs)	SP2 (kcfs)	SP3 (kcfs)	SP4 (kcfs)	SP5 (kcfs)	SP6 (kcfs)	SP7 (kcfs)	SP8 (kcfs)	SP9 (kcfs)	SP10 (kcfs)	SP11 (kcfs)	SP12 (kcfs)	SP13 (kcfs)	SP14 (kcfs)	SP15 (kcfs)	SP16 (kcfs)	SP17 (kcfs)	SP18 (kcfs)	SP19 (kcfs)	SP20 (kcfs)
7/17/2002	1900	30	0.0	6.3	7.8	7.8	6.3	6.3	4.7	4.7	4.7	4.7	4.7	4.7	3.1	3.1	3.1	3.1	3.1	1.6	0.0	0.0
7/17/2002	2000	30	0.0	6.3	7.8	7.8	6.3	6.3	4.7	4.7	4.7	4.7	4.7	4.7	3.1	3.1	3.1	3.1	3.1	1.6	0.0	0.0
7/17/2002	2100	30	0.0	6.3	7.8	7.8	6.3	6.3	4.7	4.7	4.7	4.7	4.7	4.7	3.1	3.1	3.1	3.1	3.1	1.6	0.0	0.0
7/17/2002	2200	30	0.0	6.2	7.8	7.8	6.2	6.2	6.2	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	3.1	1.6	0.0	0.0
7/17/2002	2300	30	0.0	6.2	7.8	7.8	6.2	6.2	6.2	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	3.1	1.6	0.0	0.0
7/18/2002	0000	30	0.0	6.4	6.4	6.4	6.4	4.8	4.8	4.8	4.8	4.8	3.2	3.2	3.2	3.2	3.2	3.2	1.6	0.0	0.0	0.0
7/18/2002	0100	30	0.0	6.4	6.4	6.4	6.4	4.8	4.8	4.8	4.8	4.8	3.2	3.2	3.2	3.2	3.2	3.2	1.6	0.0	0.0	0.0
7/18/2002	0200	30	0.0	6.4	6.4	6.4	6.4	4.8	4.8	4.8	4.8	4.8	3.2	3.2	3.2	3.2	3.2	3.2	1.6	0.0	0.0	0.0
7/18/2002	0300	30	0.0	6.4	6.4	6.4	6.4	4.8	4.8	4.8	4.8	4.8	3.2	3.2	3.2	3.2	3.2	3.2	1.6	0.0	0.0	0.0
7/18/2002	0400	30	0.0	6.4	6.4	6.4	6.4	4.8	4.8	4.8	4.8	4.8	3.2	3.2	3.2	3.2	3.2	3.2	1.6	0.0	0.0	0.0
7/18/2002	0500	30	0.0	6.4	6.4	6.4	6.4	4.8	4.8	4.8	4.8	4.8	3.2	3.2	3.2	3.2	3.2	3.2	1.6	0.0	0.0	0.0
7/18/2002	0600	30	0.0	6.4	6.4	6.4	6.4	4.8	4.8	4.8	4.8	4.8	3.2	3.2	3.2	3.2	3.2	3.2	1.6	0.0	0.0	0.0

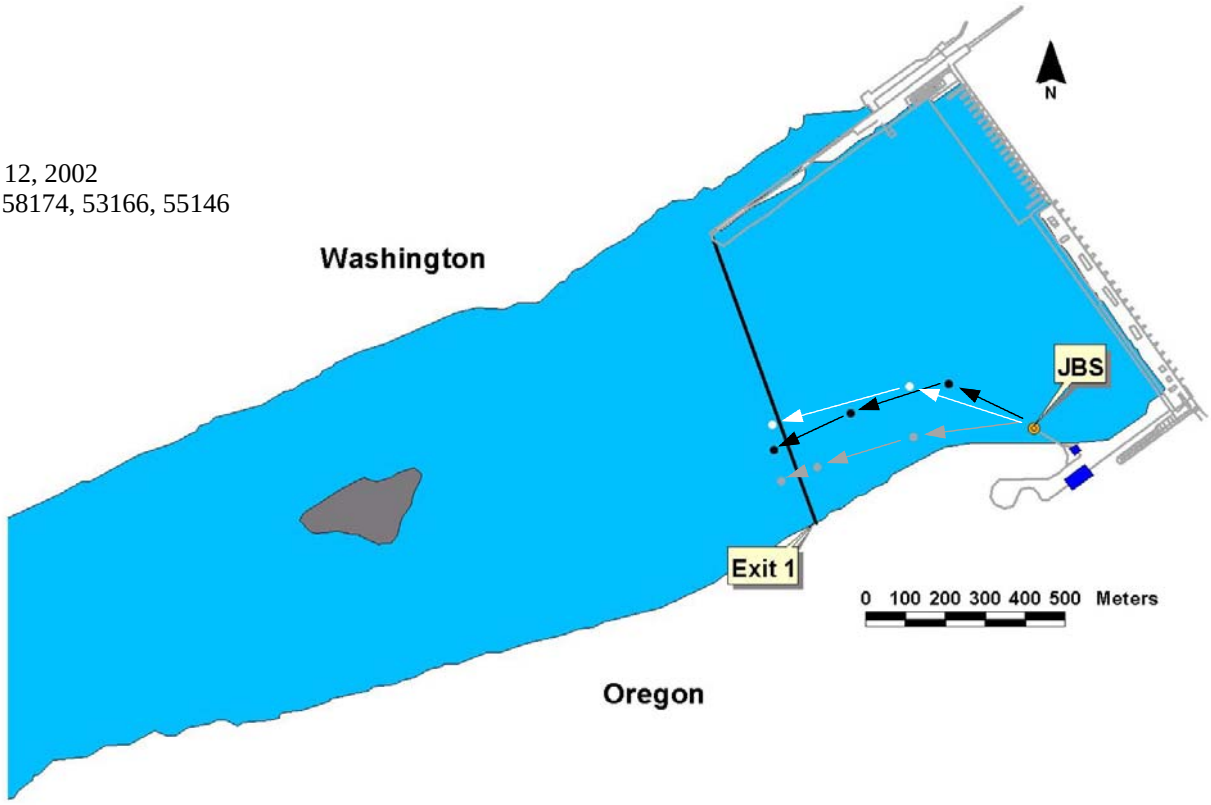
Appendix 4. Individual tracks of fish released through the juvenile bypass system at John Day Dam, 2002.

30% Spill; Yearling Chinook Salmon

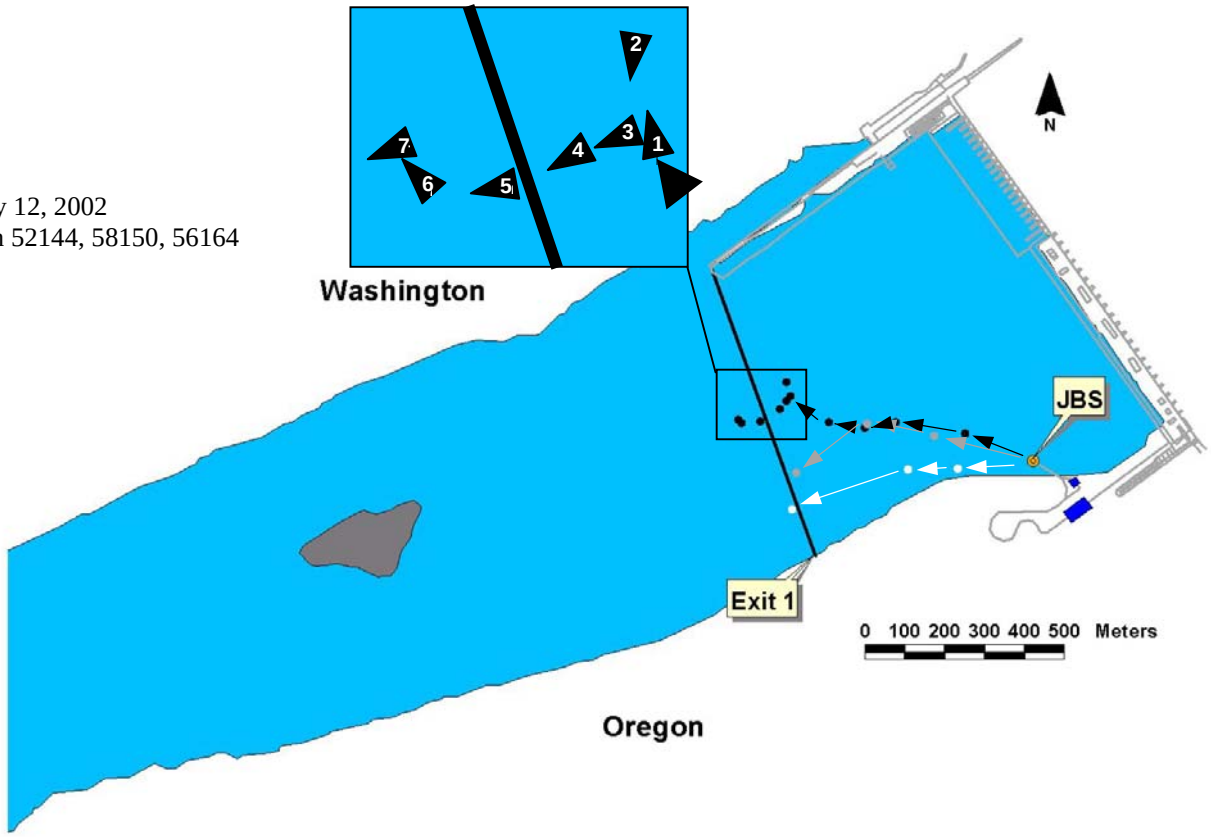
May 10, 2002
Fish 58148, 55144, 53168, 55174



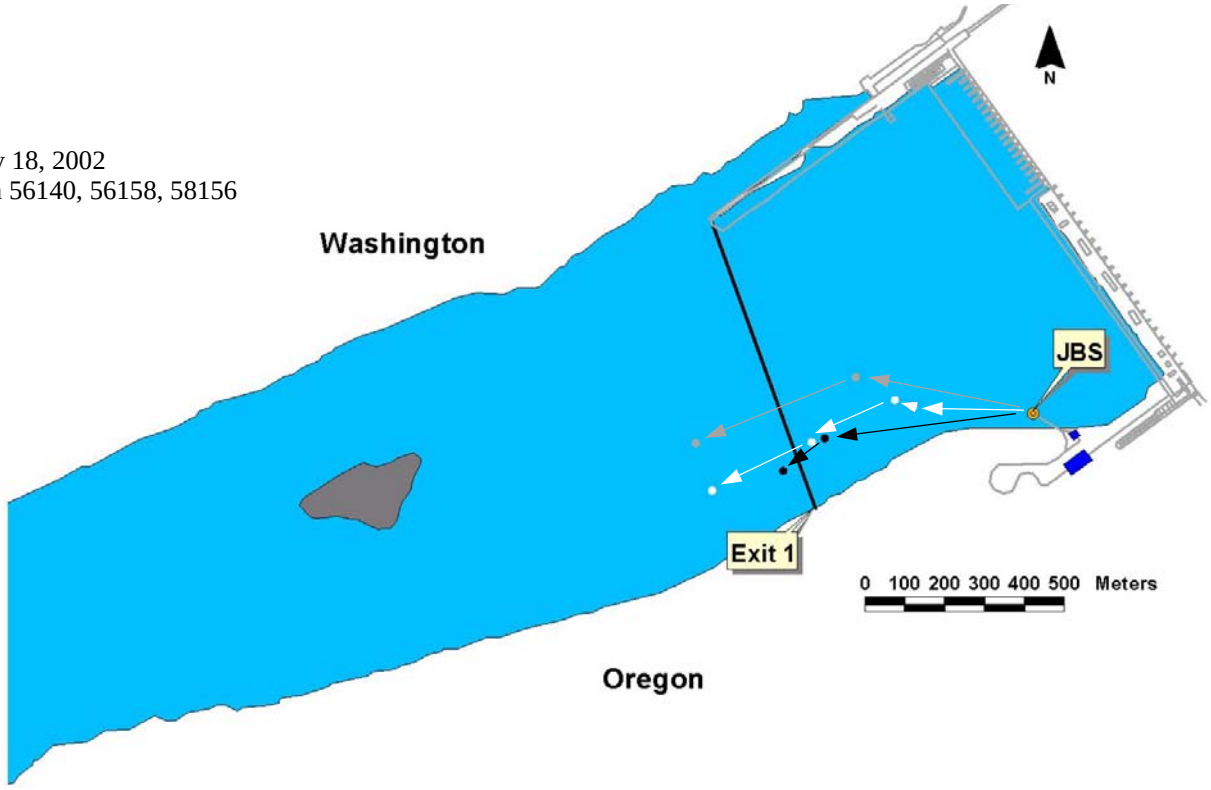
May 12, 2002
Fish 58174, 53166, 55146



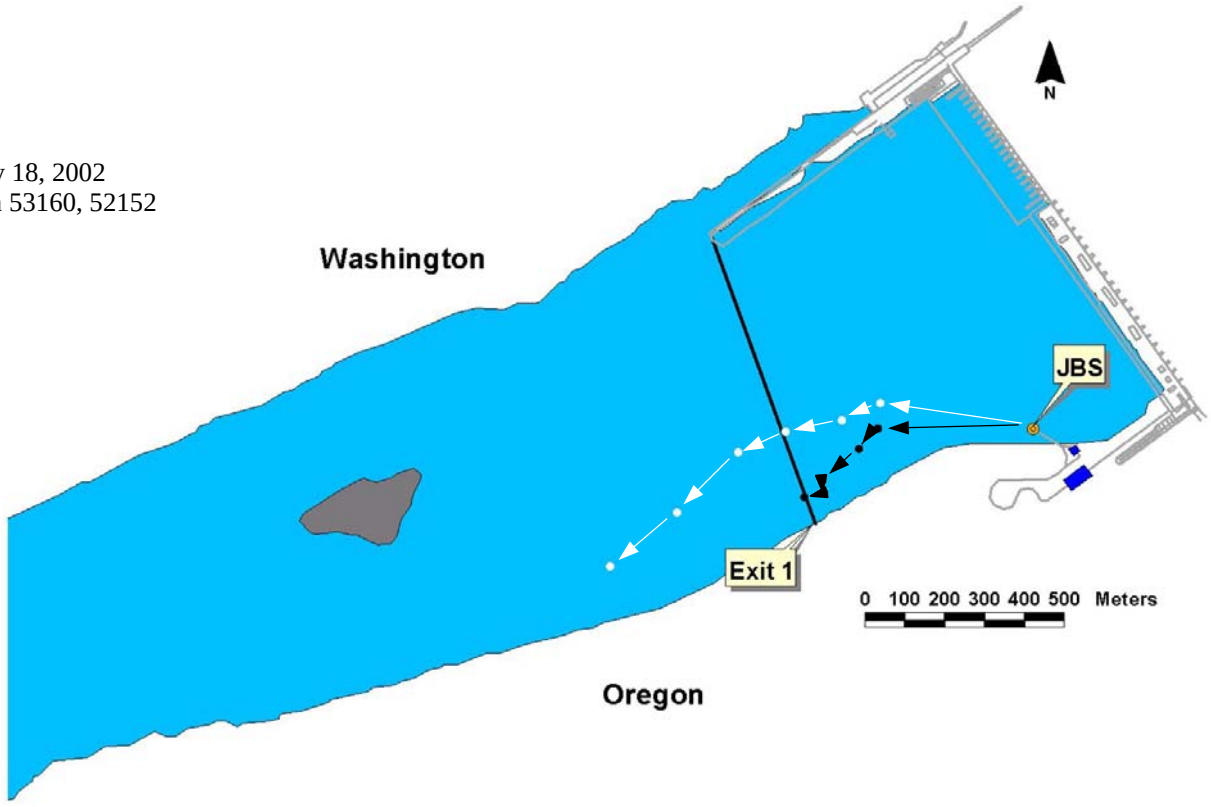
May 12, 2002
Fish 52144, 58150, 56164



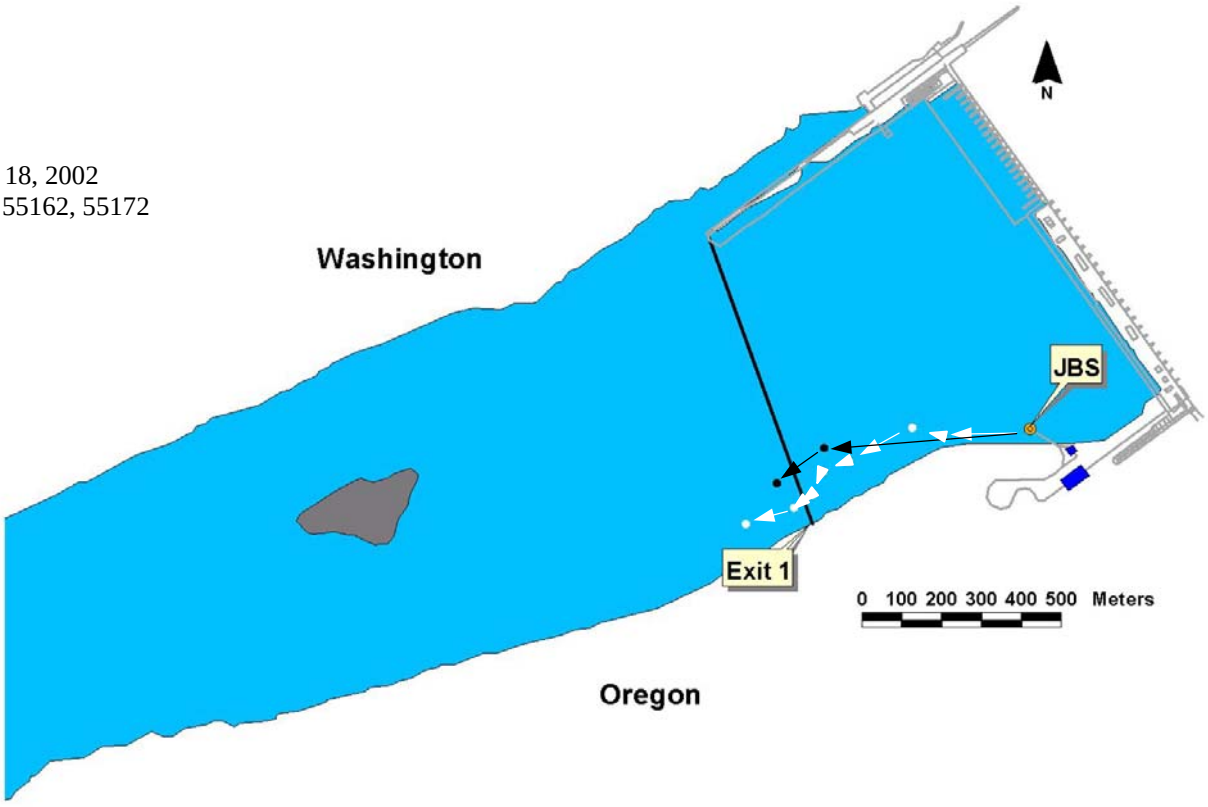
May 18, 2002
Fish 56140, 56158, 58156



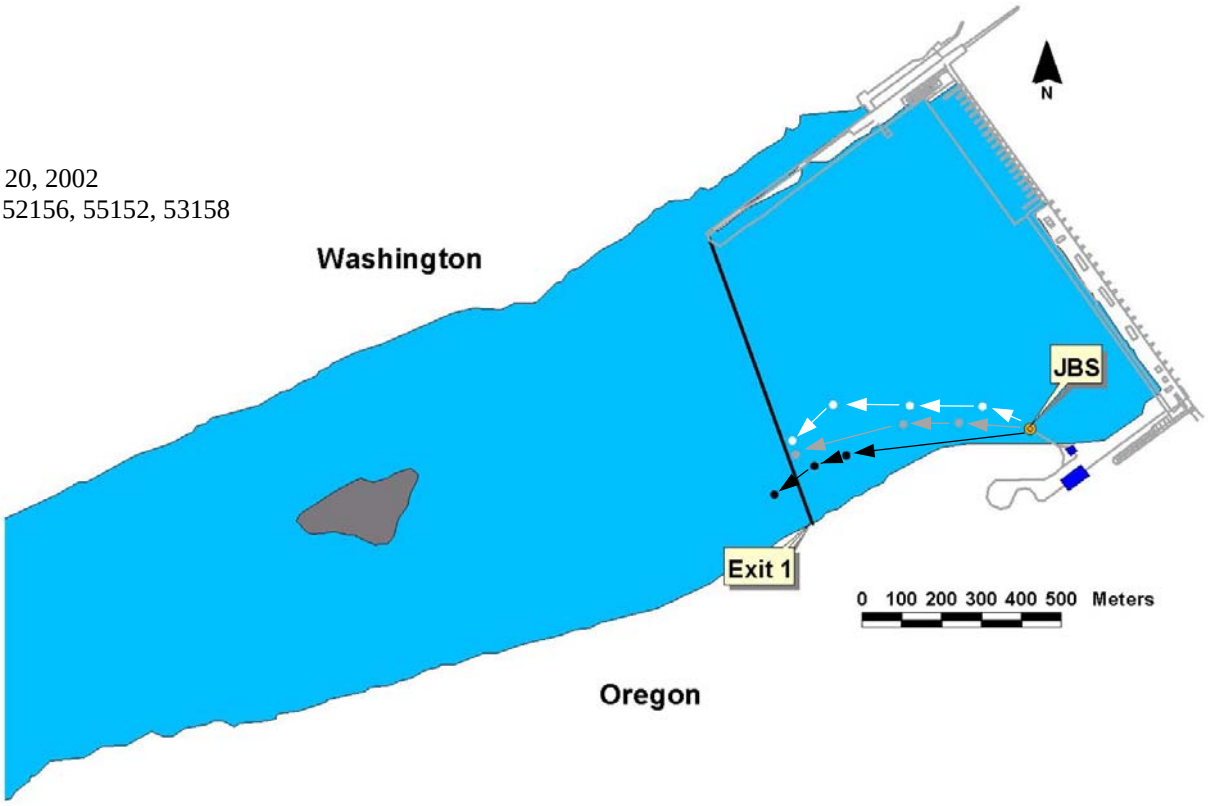
May 18, 2002
Fish 53160, 52152



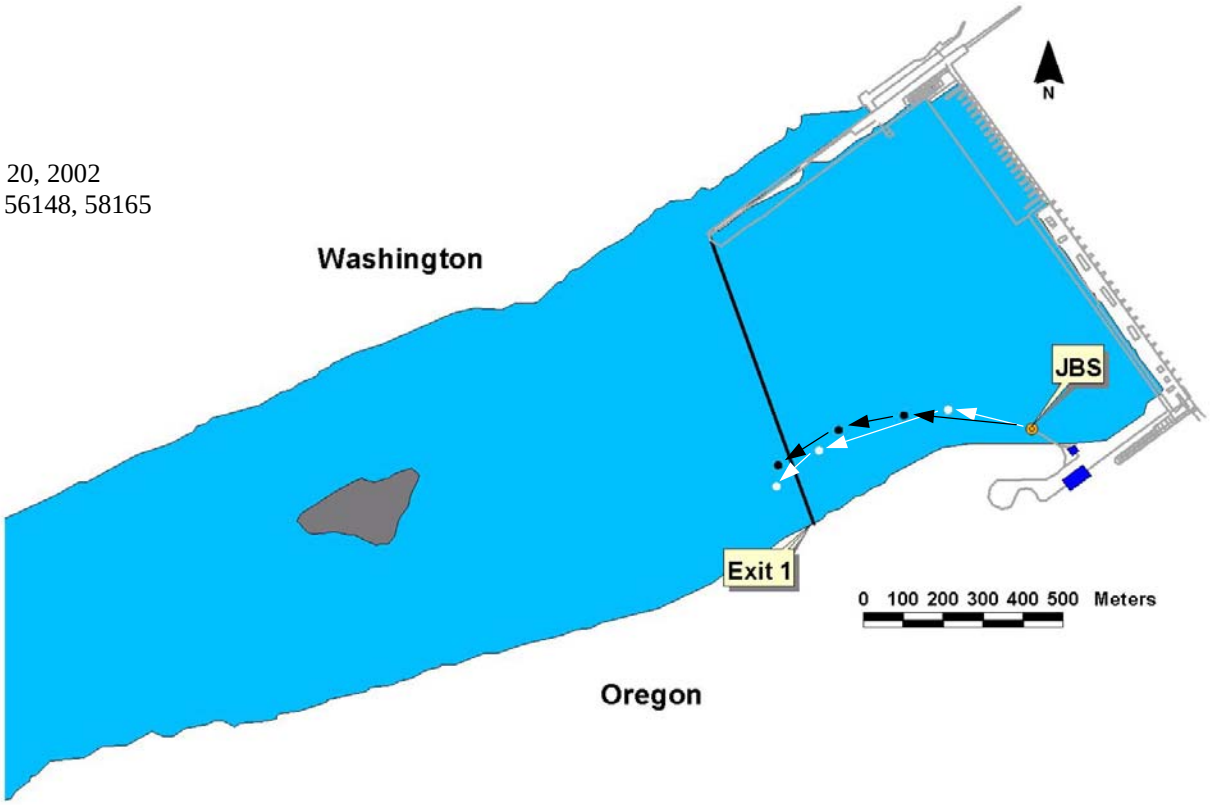
May 18, 2002
Fish 55162, 55172



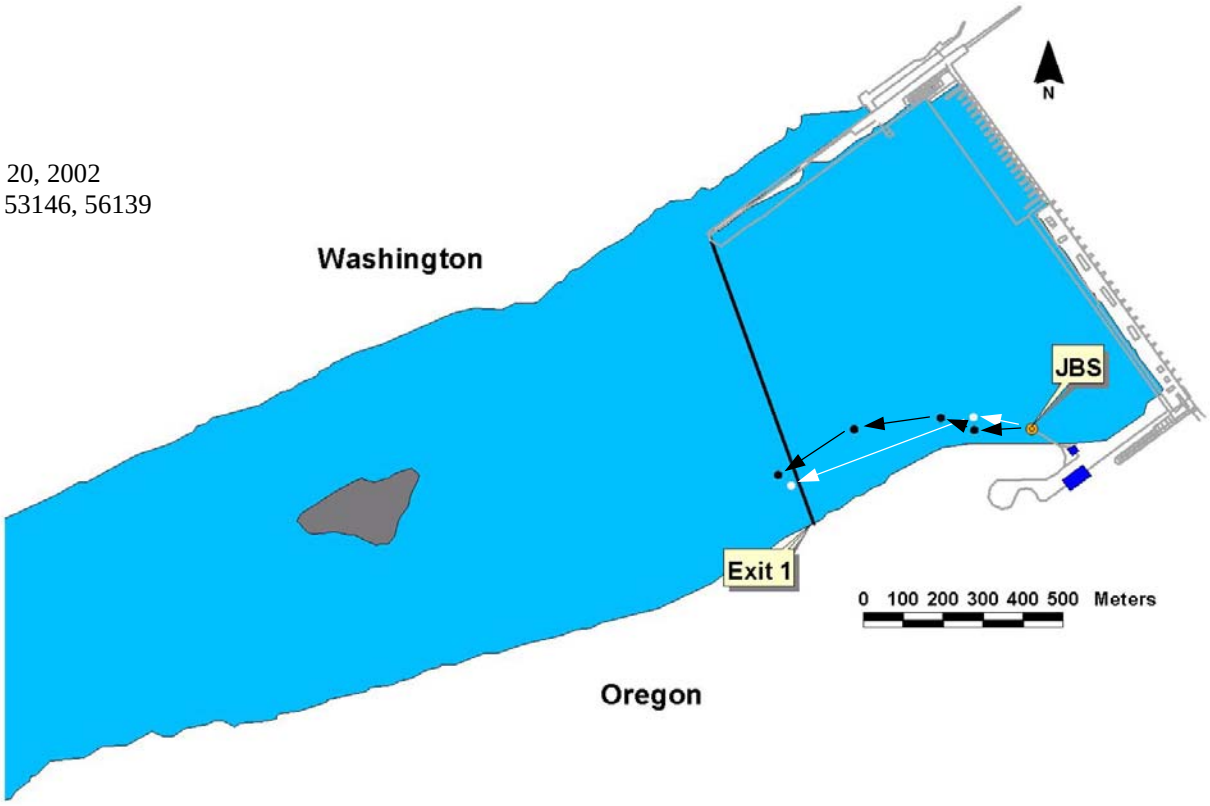
May 20, 2002
Fish 52156, 55152, 53158



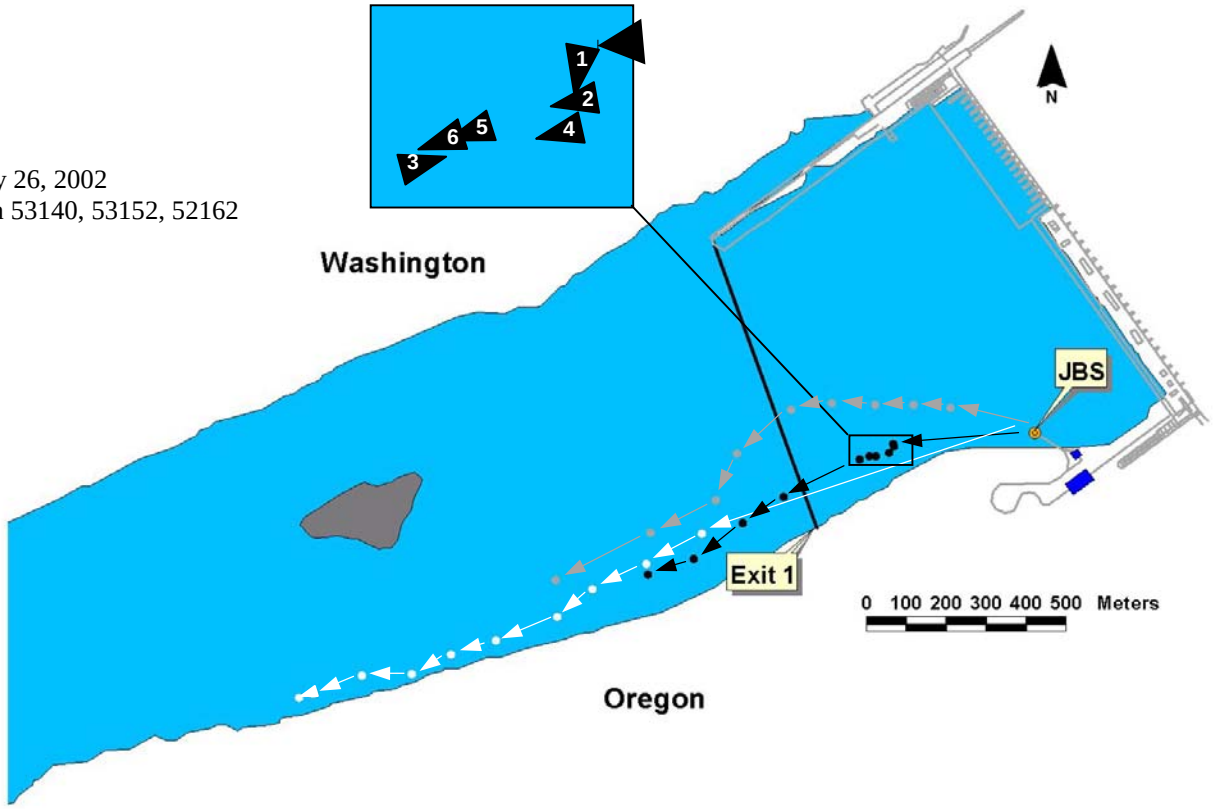
May 20, 2002
Fish 56148, 58165



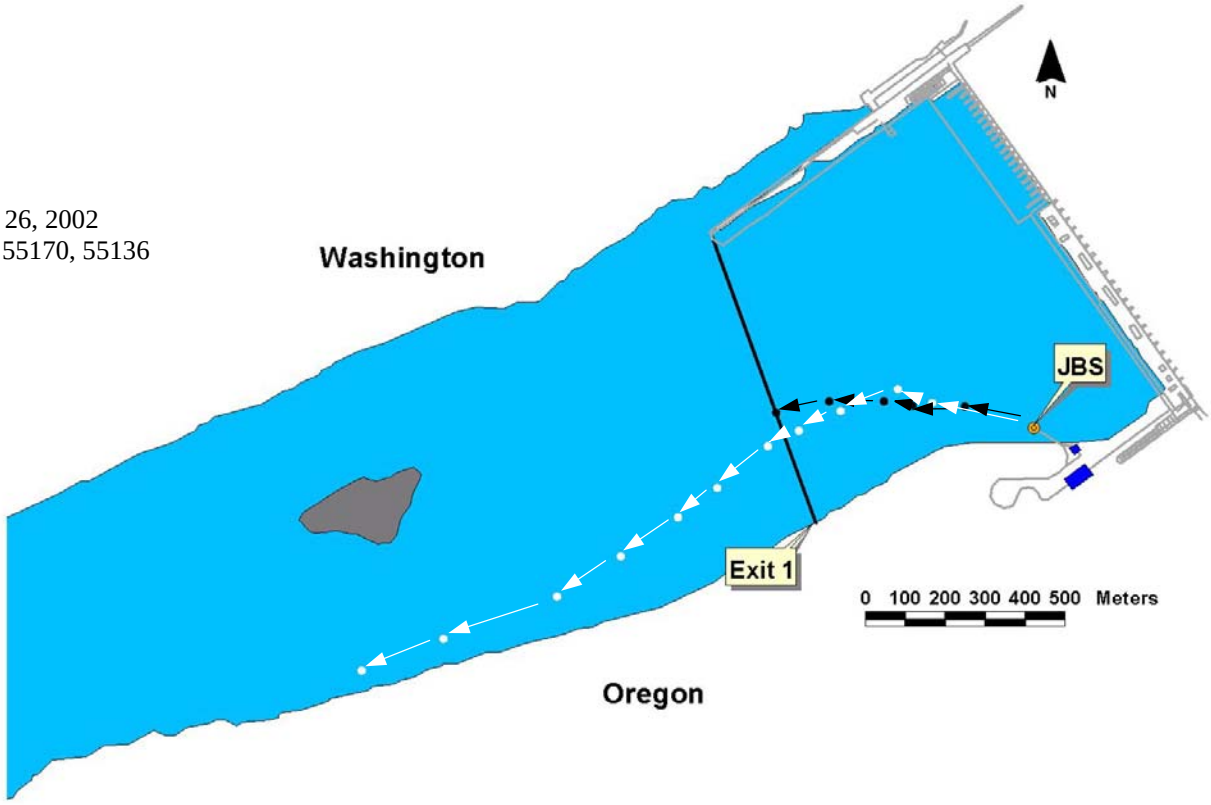
May 20, 2002
Fish 53146, 56139



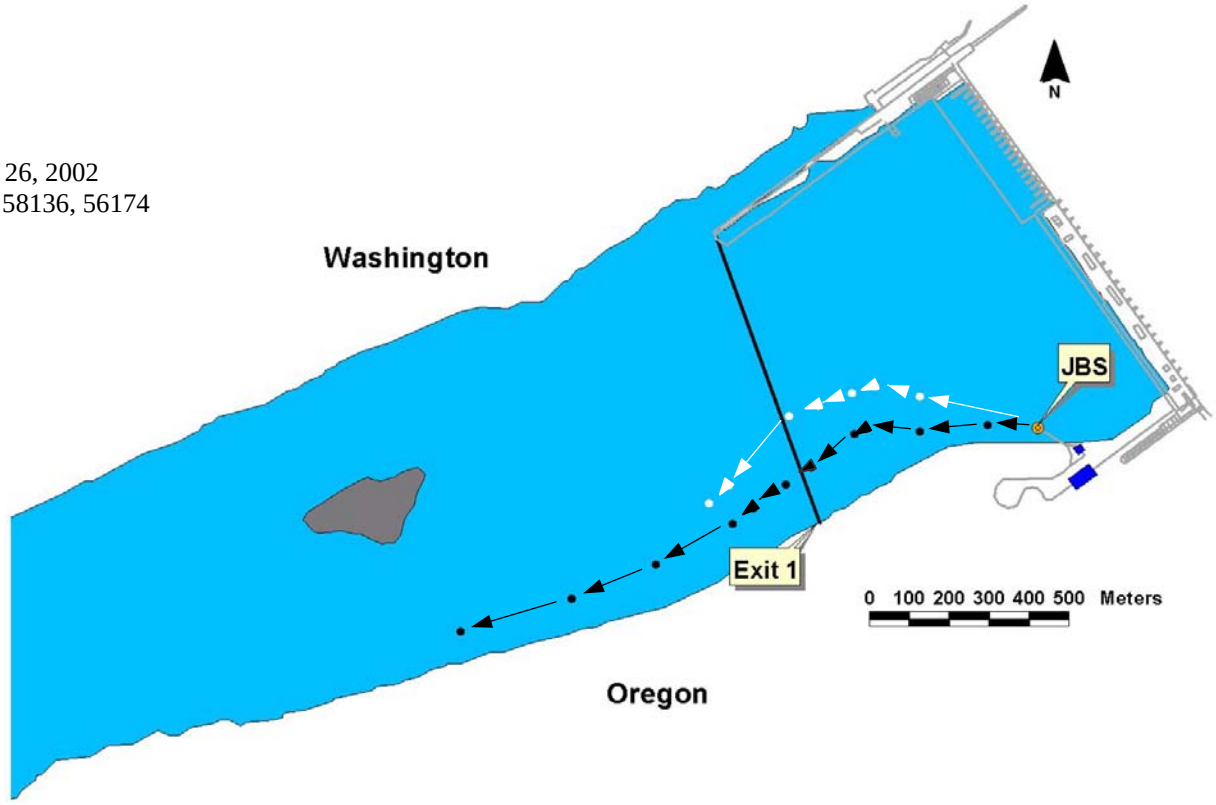
May 26, 2002
Fish 53140, 53152, 52162



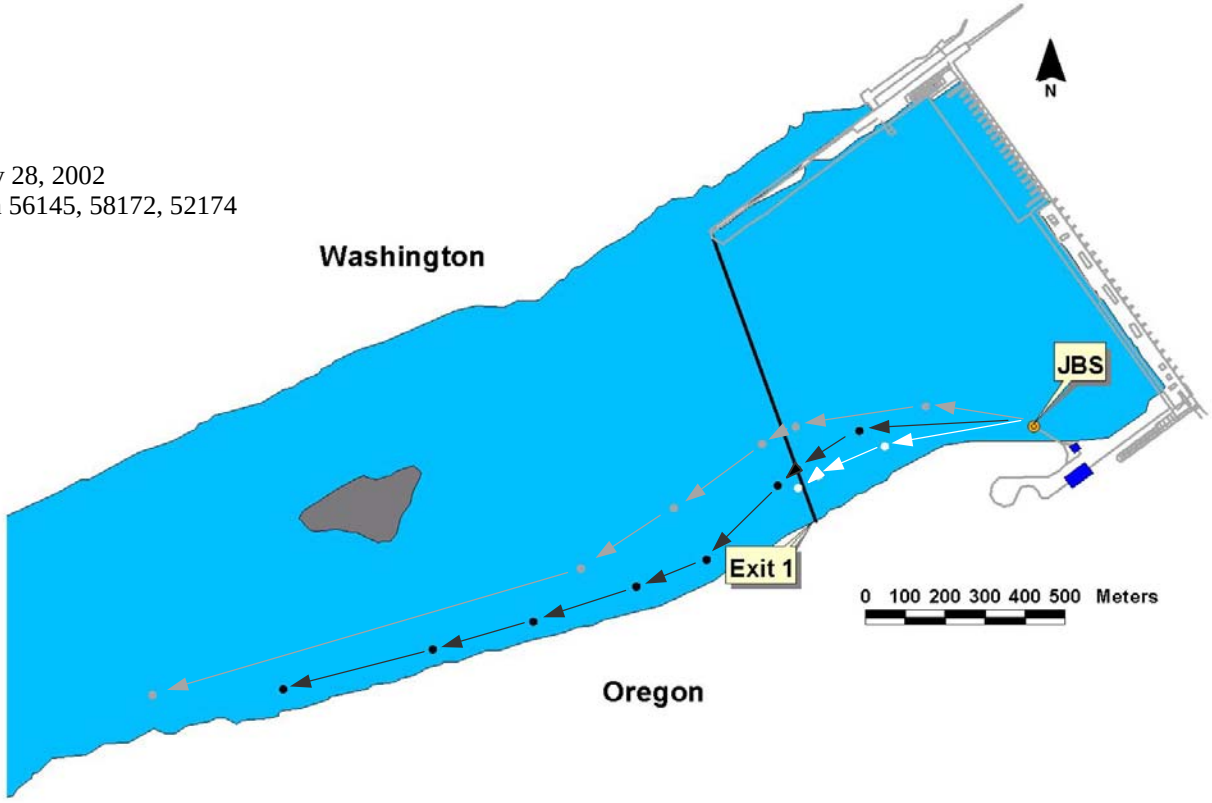
May 26, 2002
Fish 55170, 55136



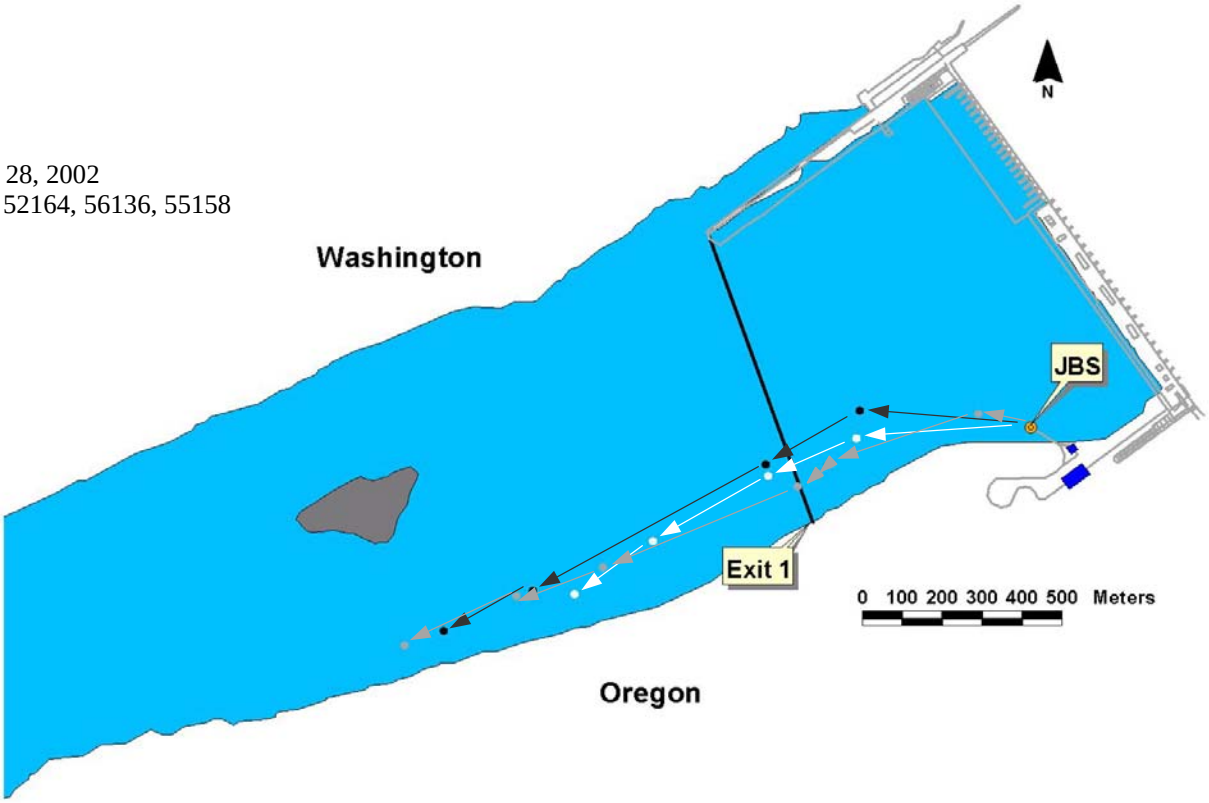
May 26, 2002
Fish 58136, 56174



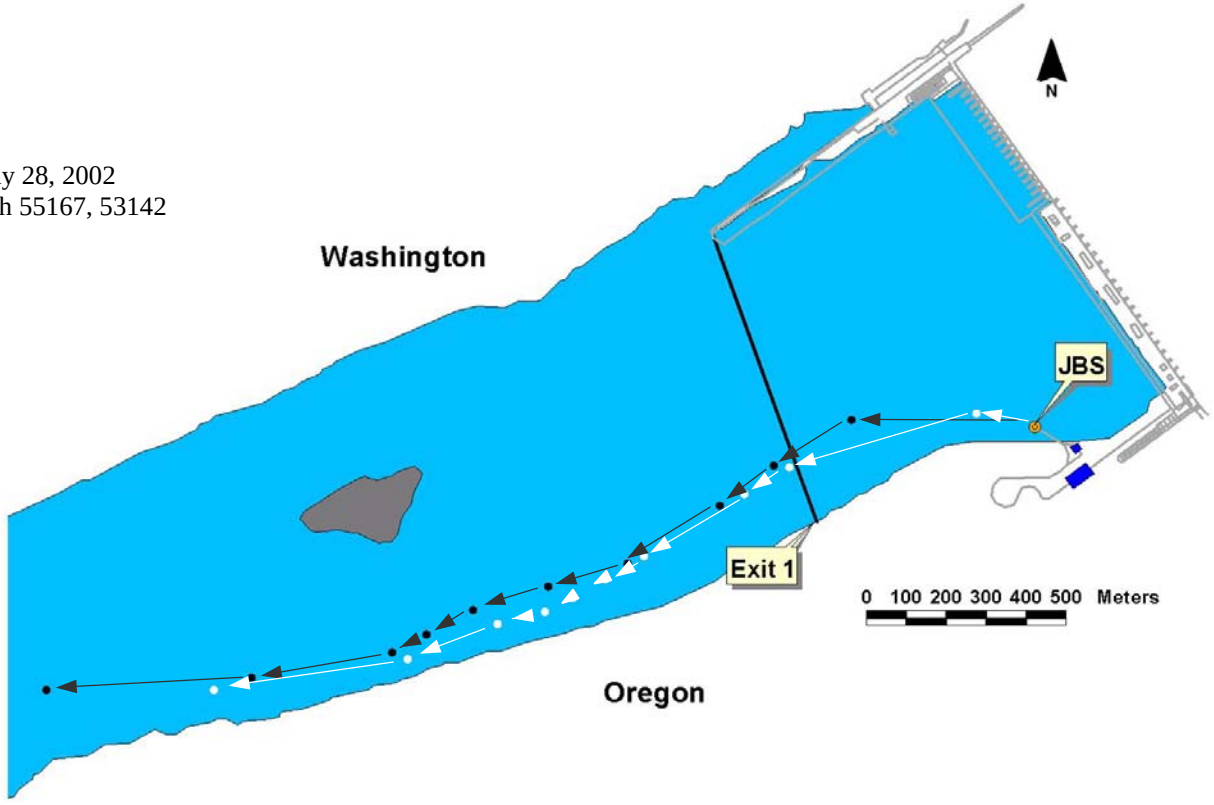
May 28, 2002
Fish 56145, 58172, 52174



May 28, 2002
Fish 52164, 56136, 55158

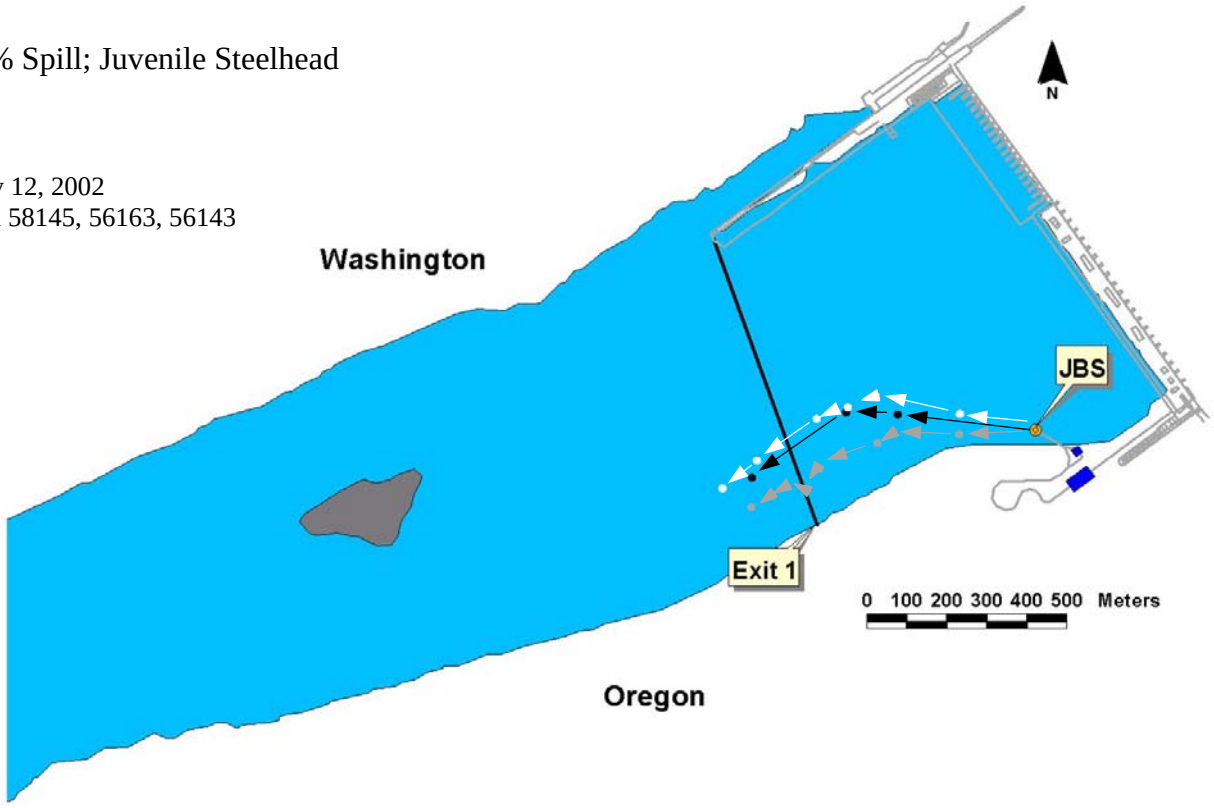


May 28, 2002
Fish 55167, 53142

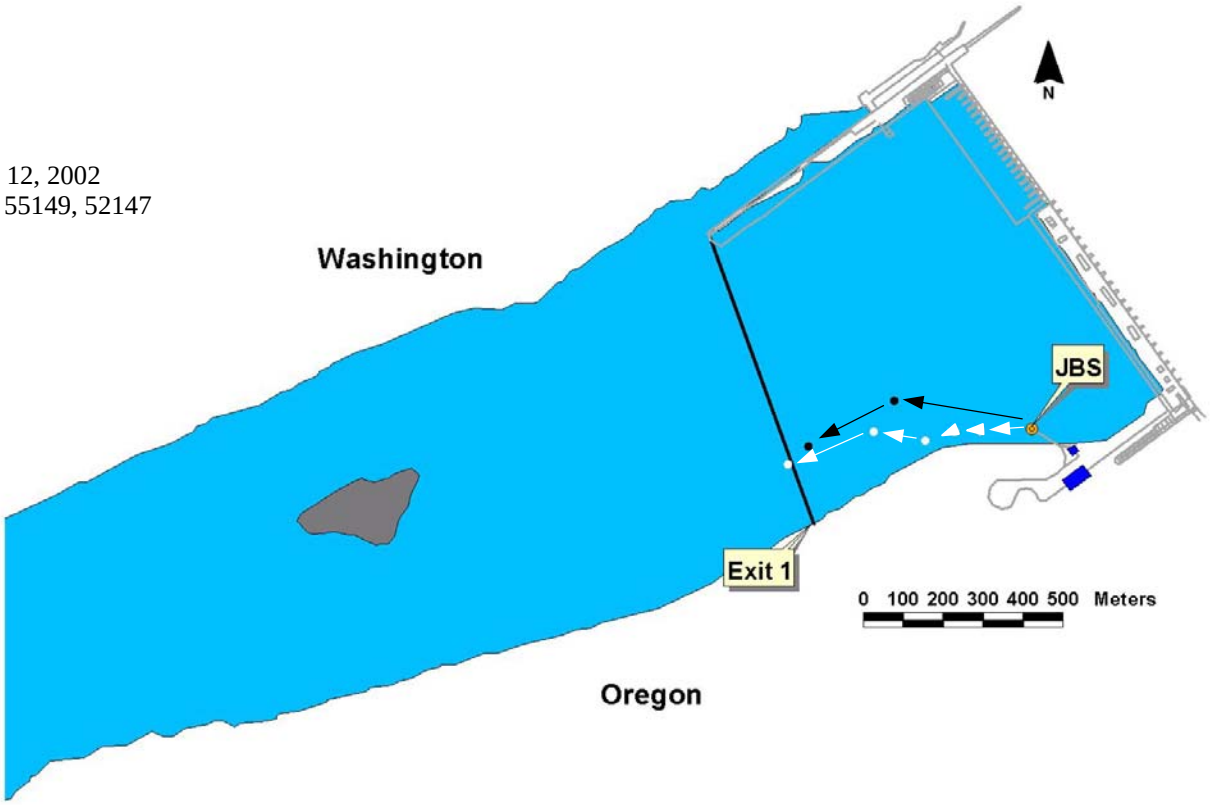


30% Spill; Juvenile Steelhead

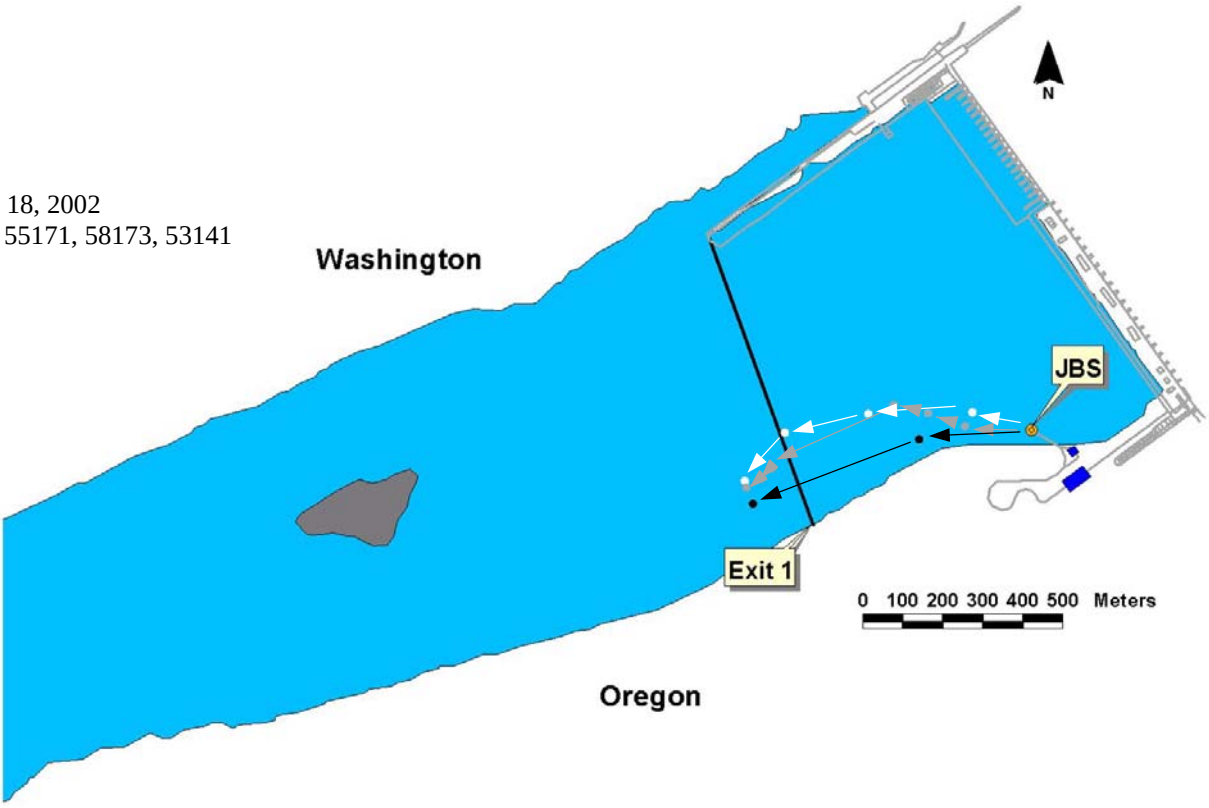
May 12, 2002
Fish 58145, 56163, 56143



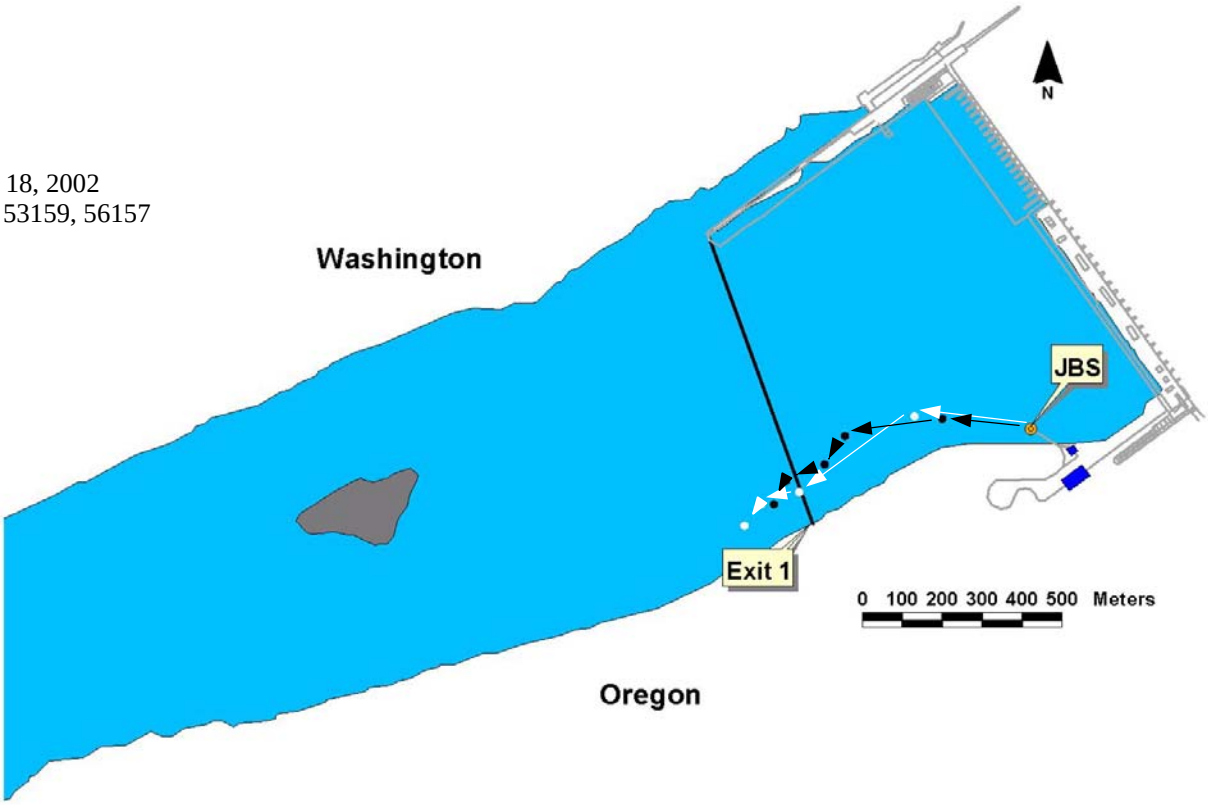
May 12, 2002
Fish 55149, 52147



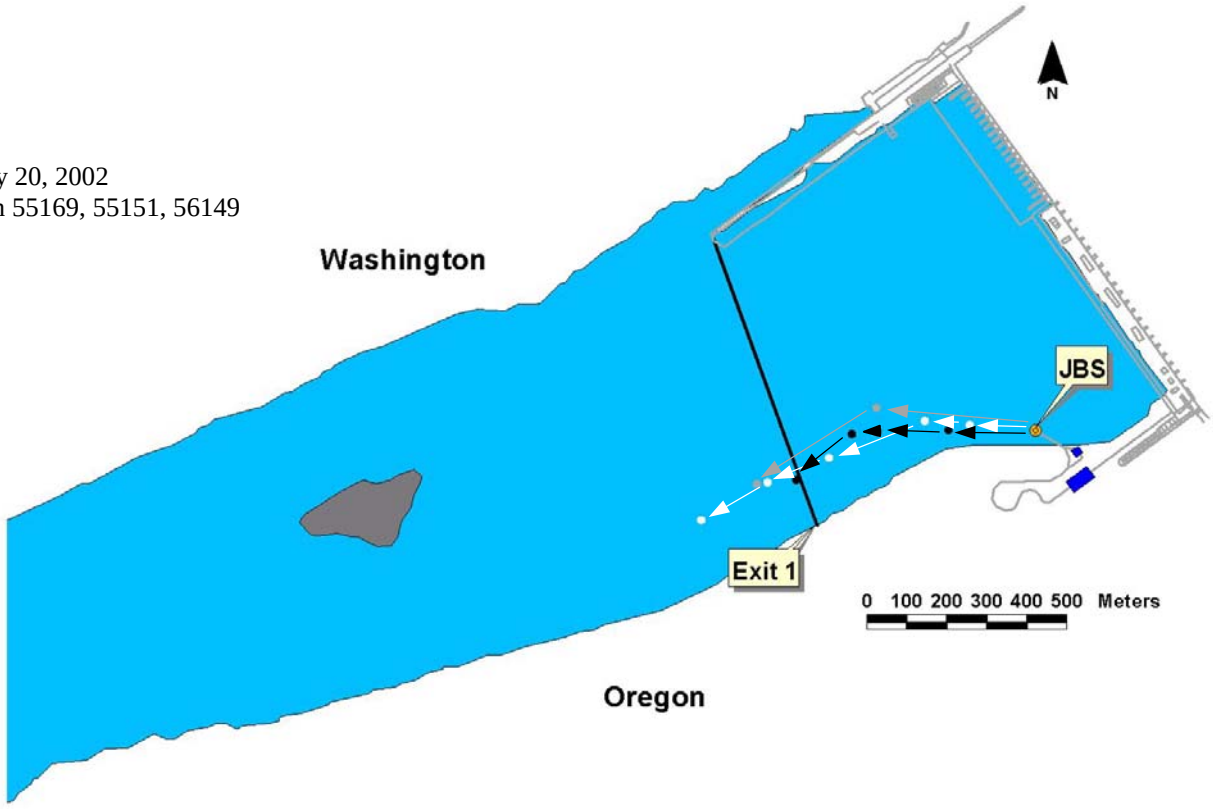
May 18, 2002
Fish 55171, 58173, 53141



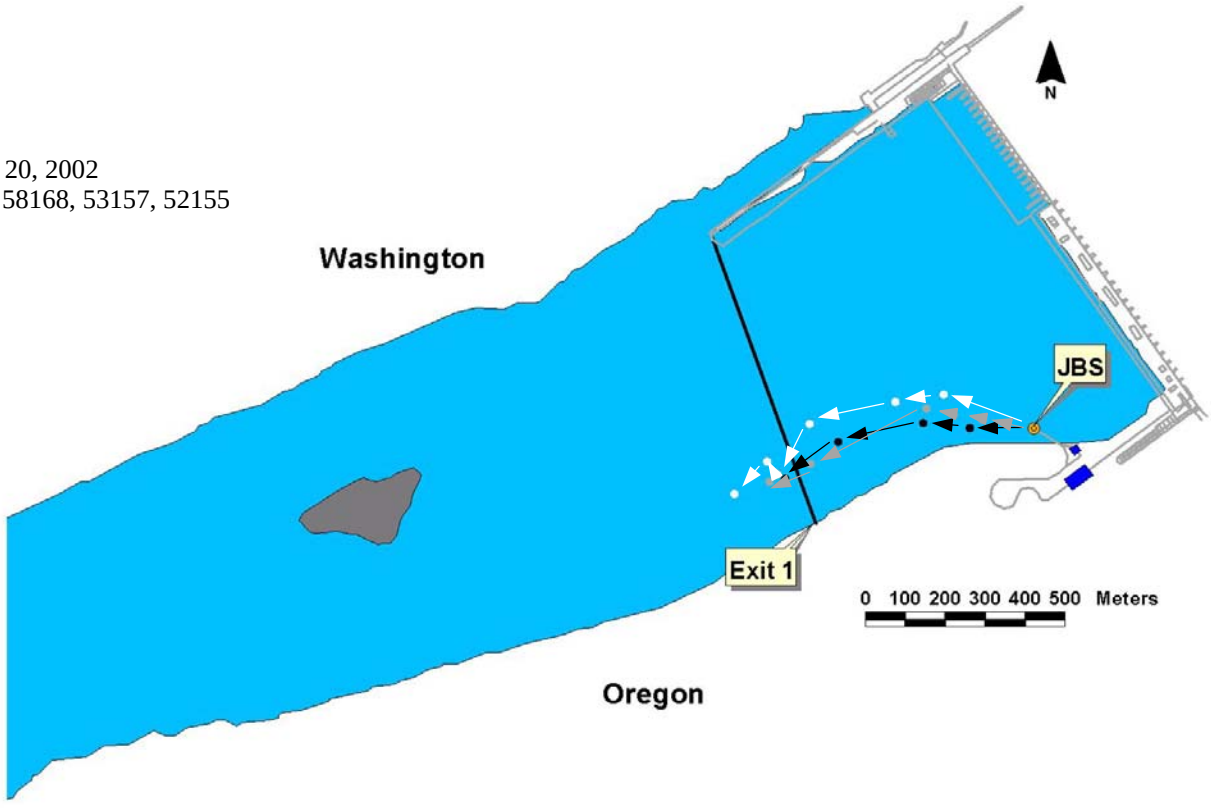
May 18, 2002
Fish 53159, 56157



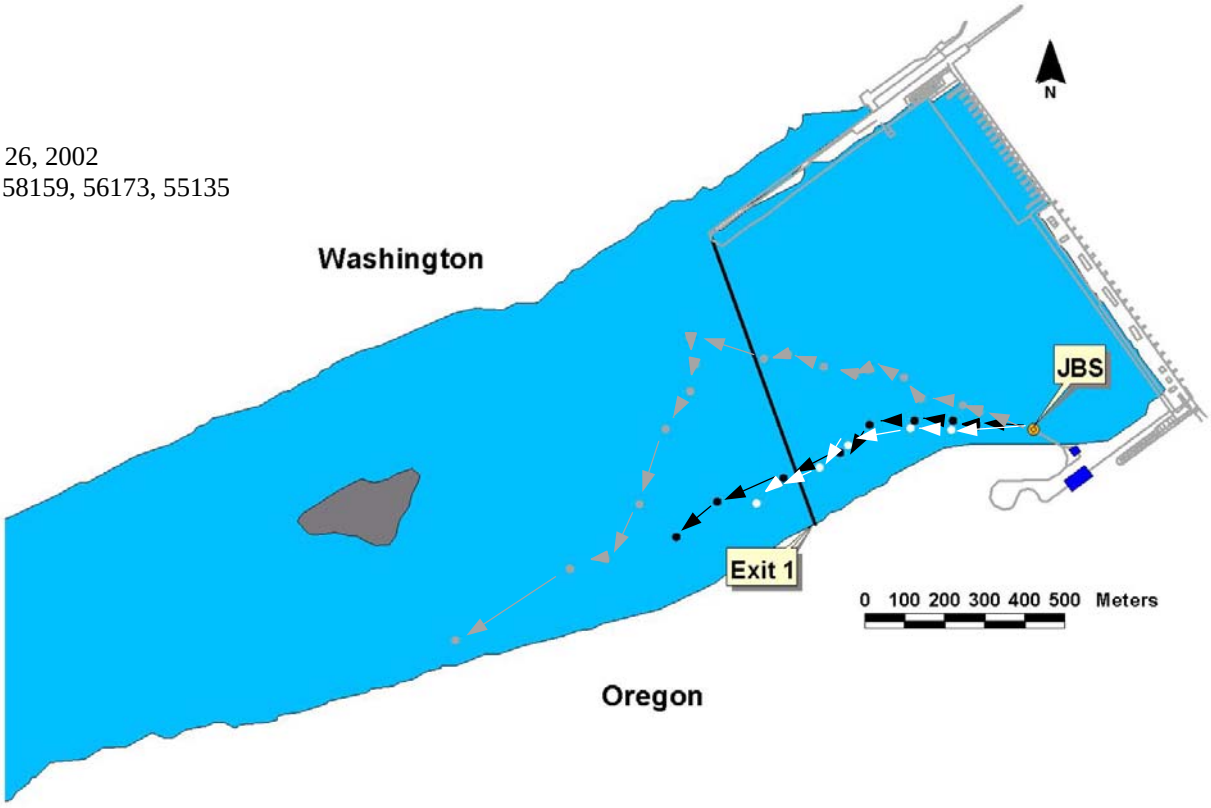
May 20, 2002
Fish 55169, 55151, 56149



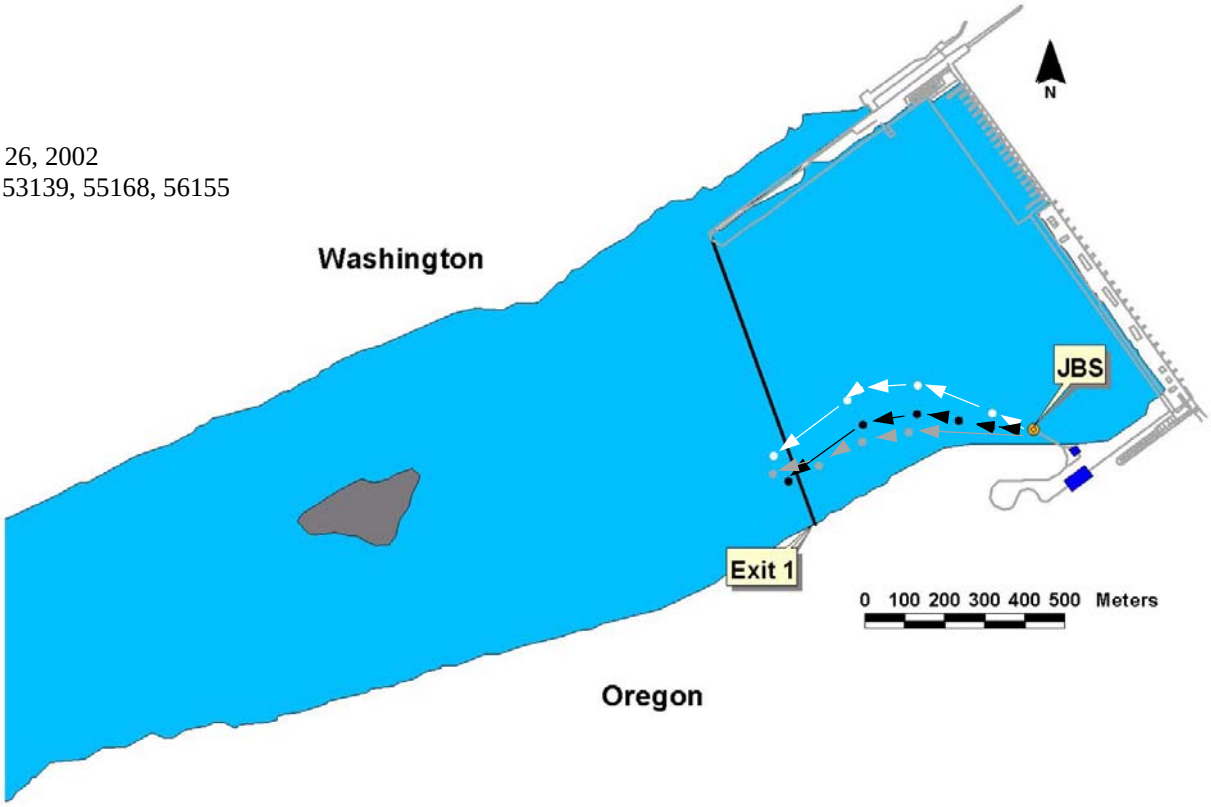
May 20, 2002
Fish 58168, 53157, 52155



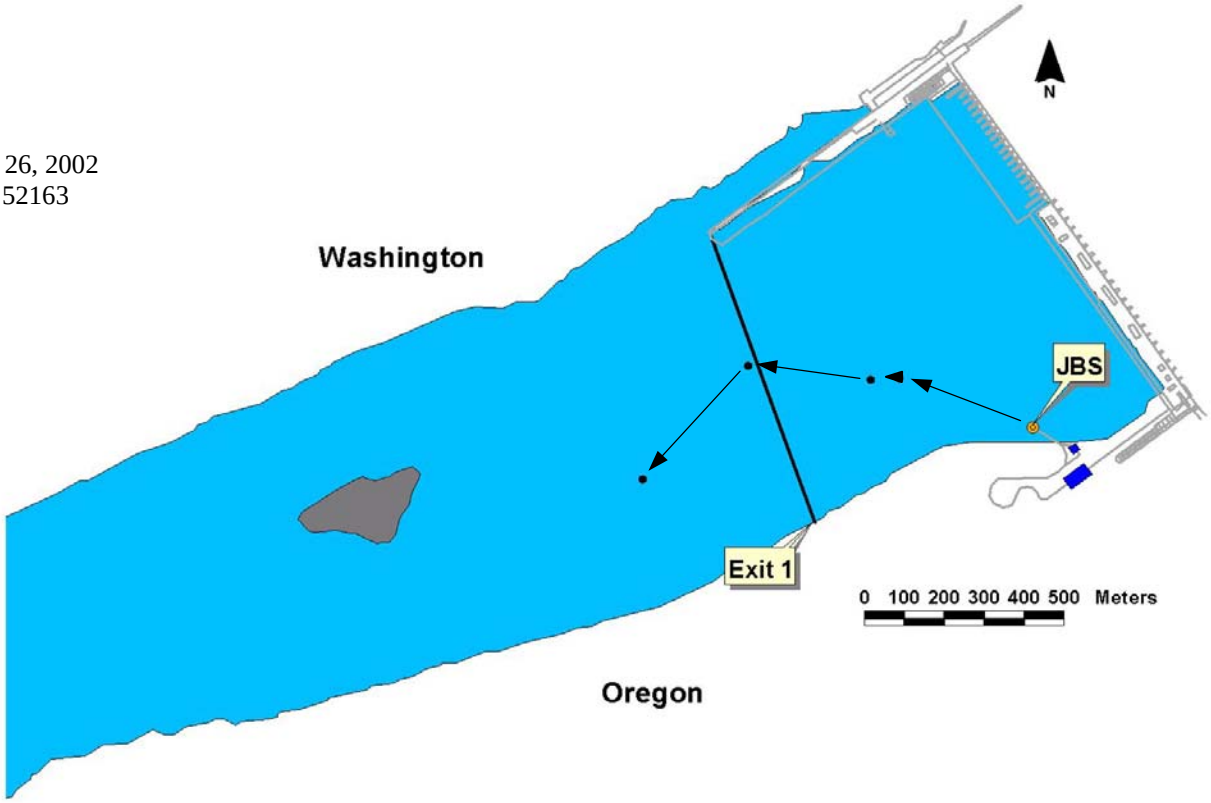
May 26, 2002
Fish 58159, 56173, 55135



May 26, 2002
Fish 53139, 55168, 56155

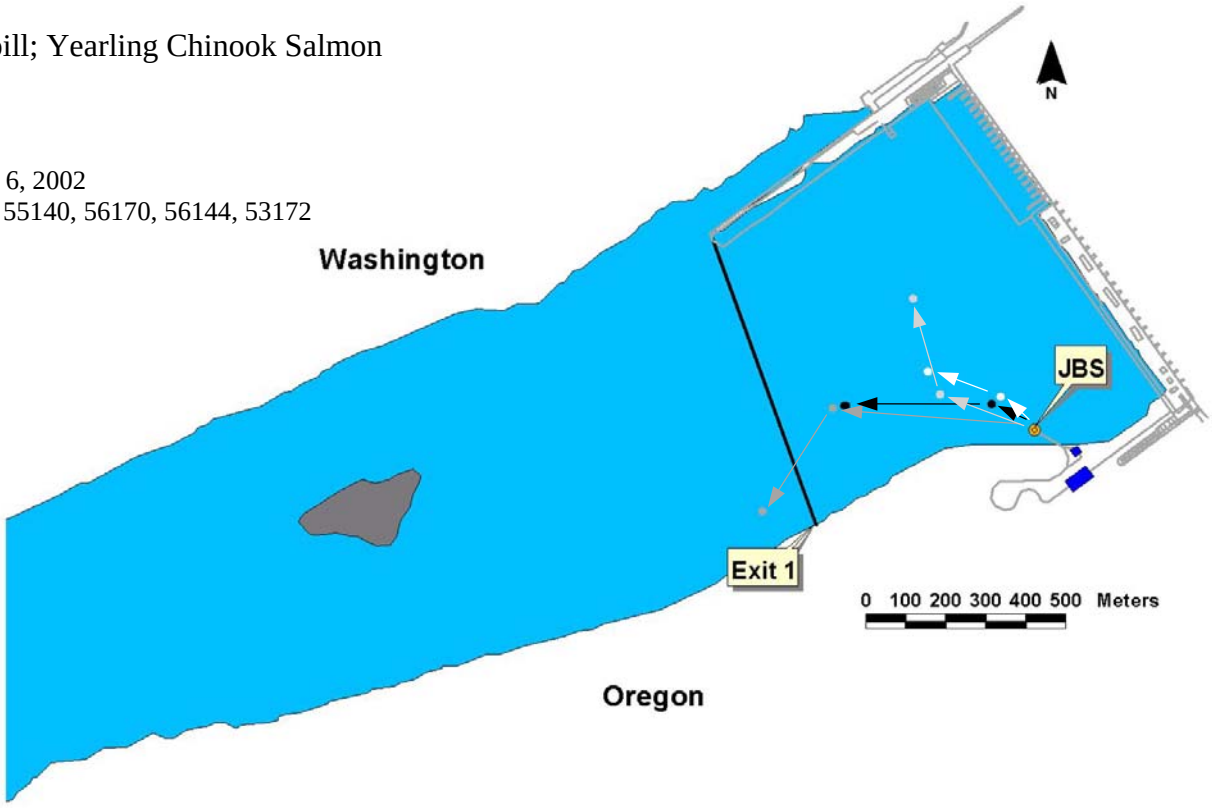


May 26, 2002
Fish 52163

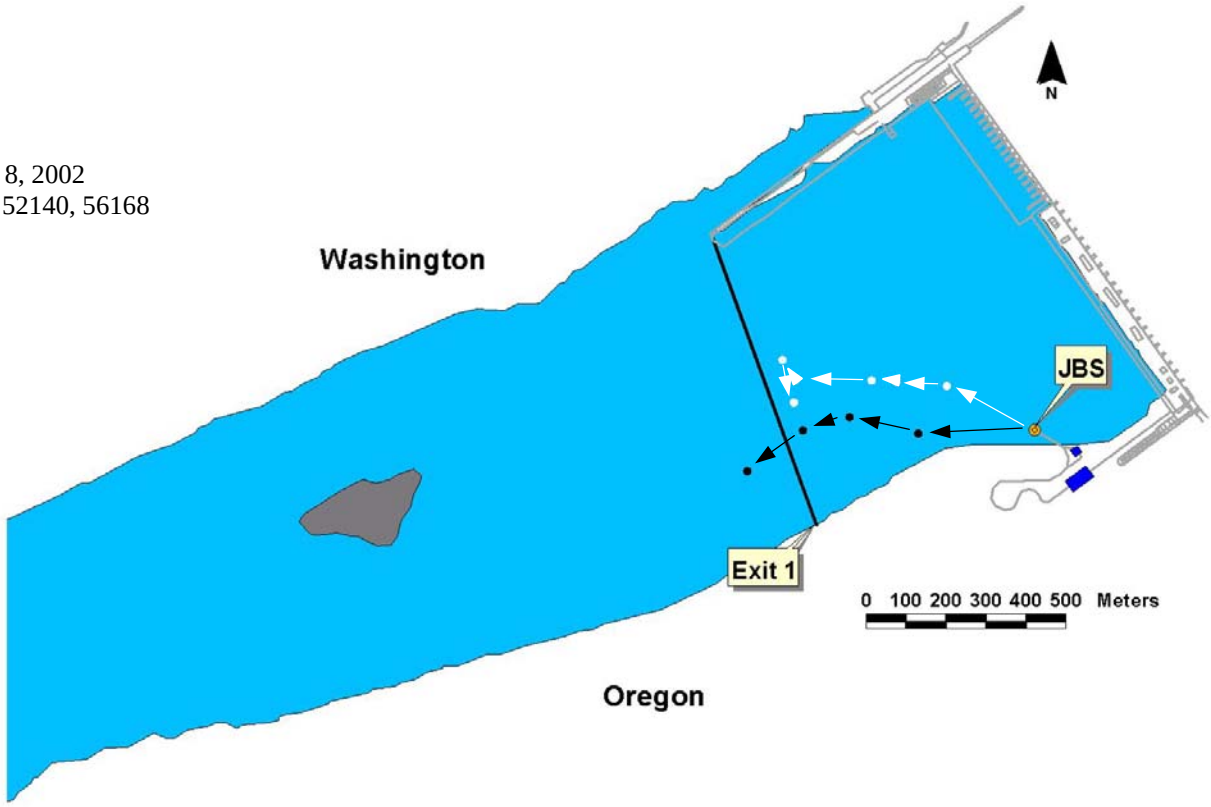


57% Spill; Yearling Chinook Salmon

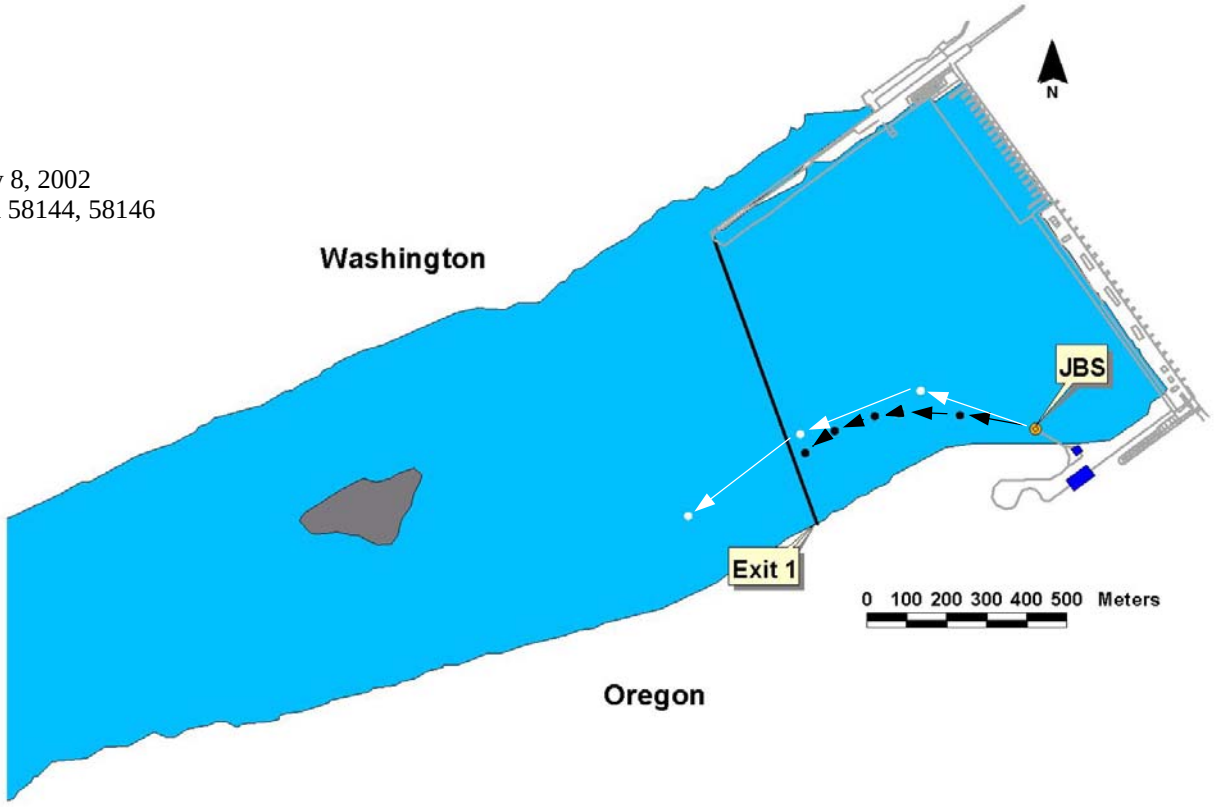
May 6, 2002
Fish 55140, 56170, 56144, 53172



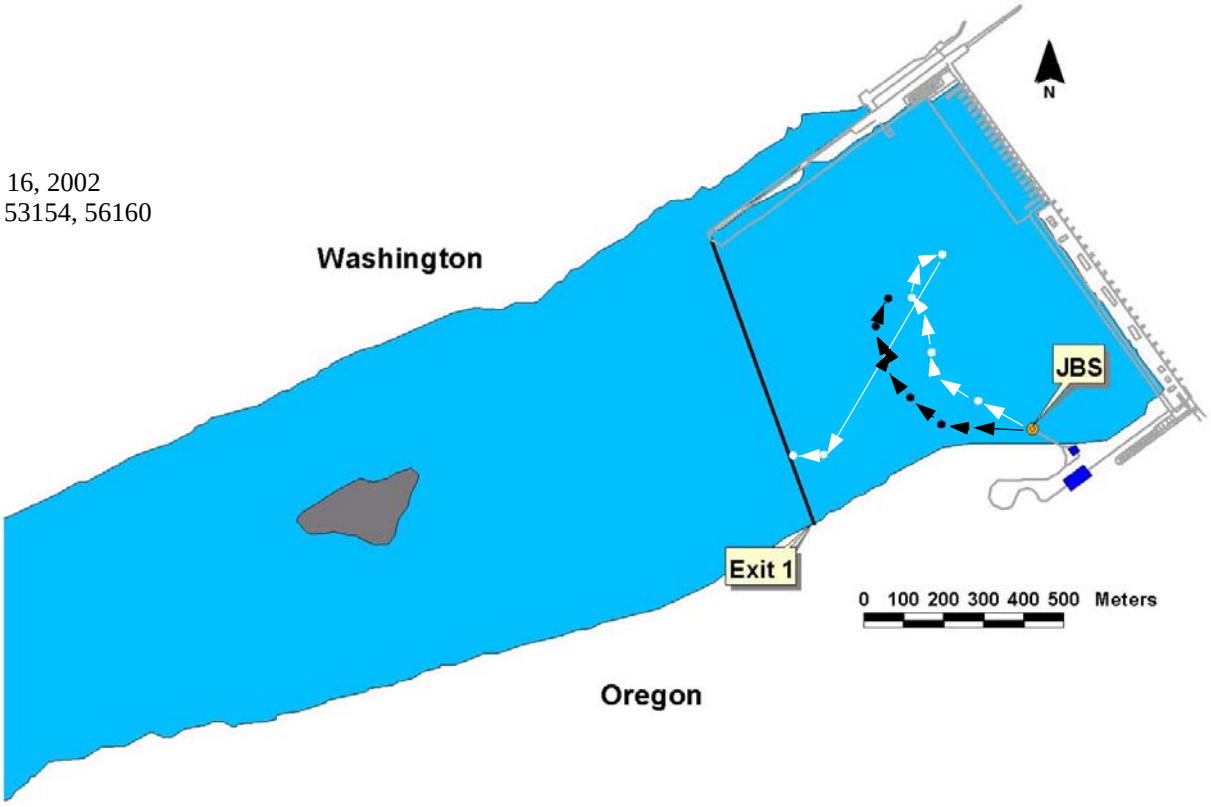
May 8, 2002
Fish 52140, 56168



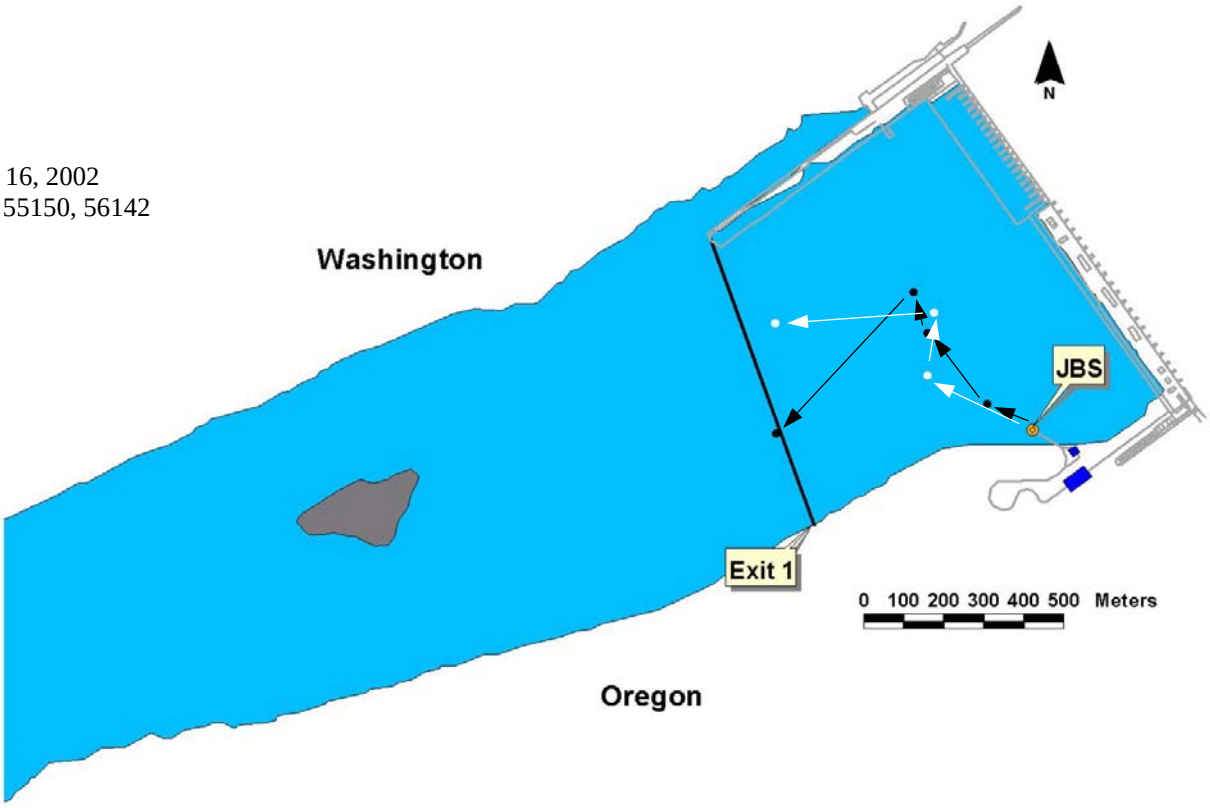
May 8, 2002
Fish 58144, 58146



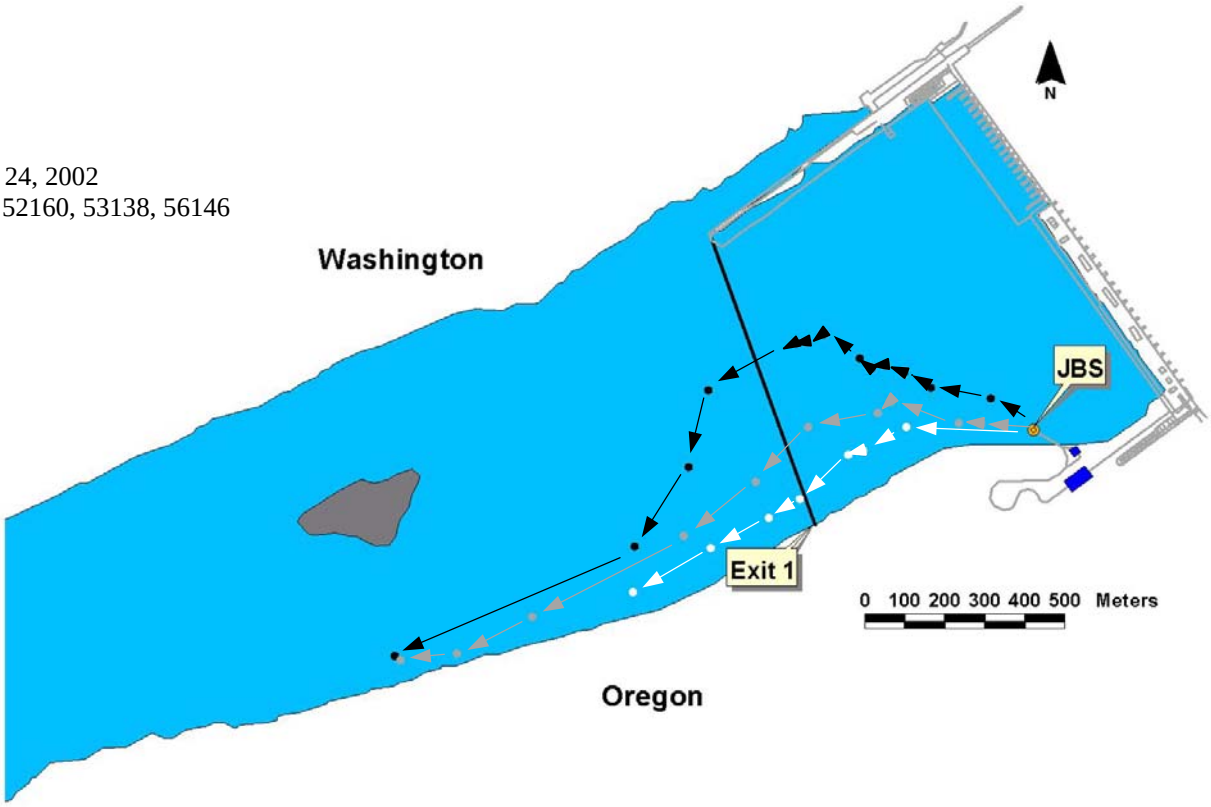
May 16, 2002
Fish 53154, 56160



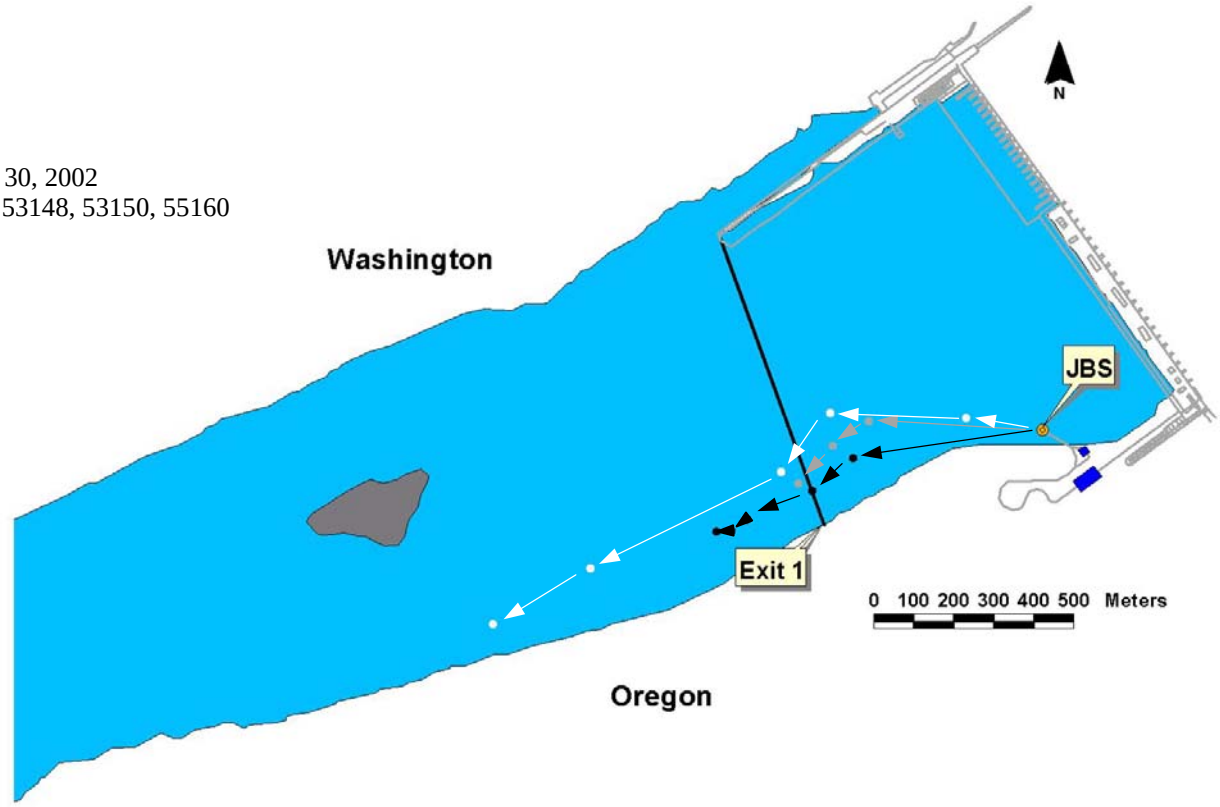
May 16, 2002
Fish 55150, 56142



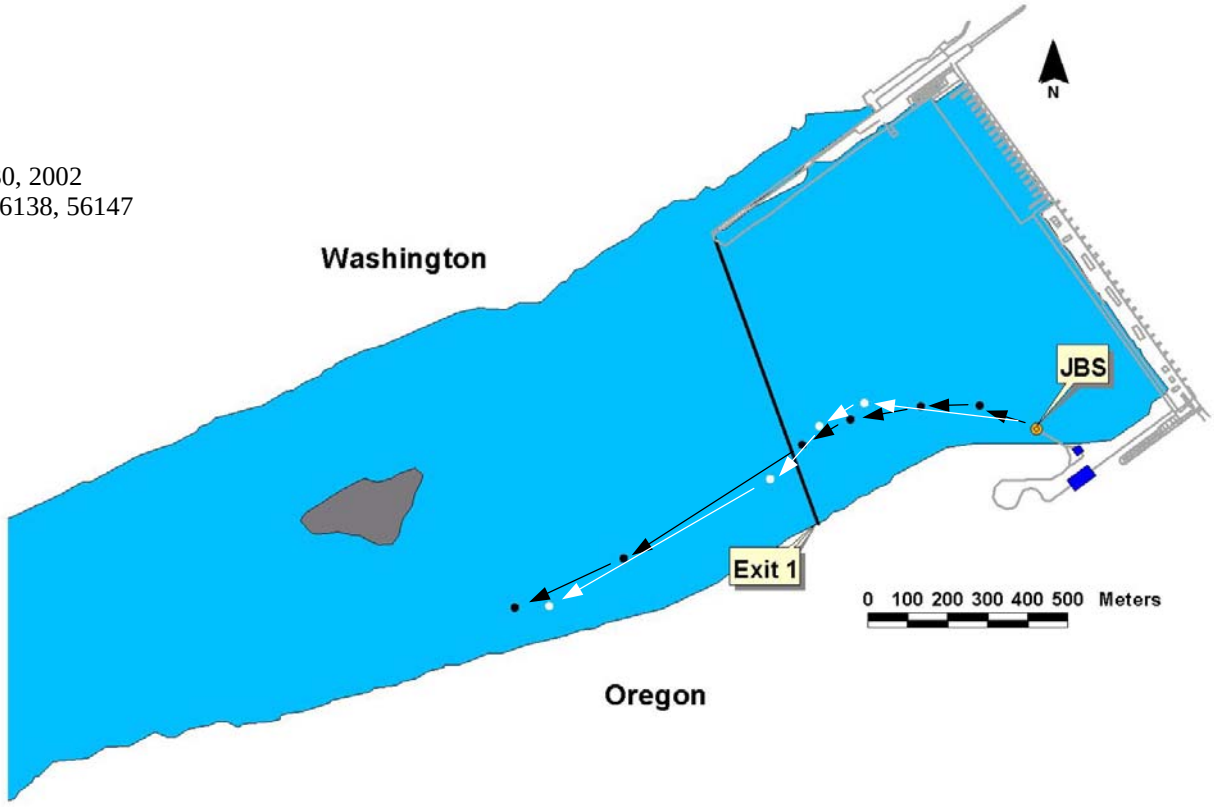
May 24, 2002
Fish 52160, 53138, 56146



May 30, 2002
Fish 53148, 53150, 55160

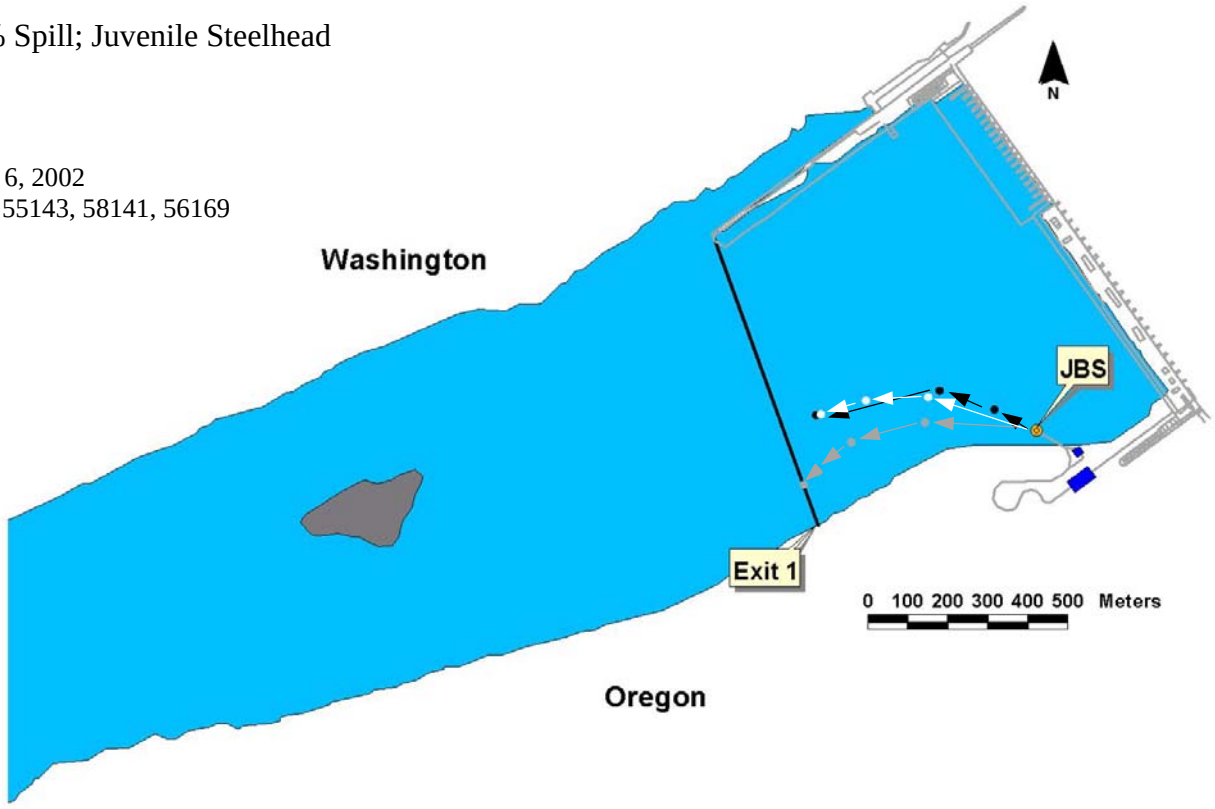


May 30, 2002
Fish 56138, 56147

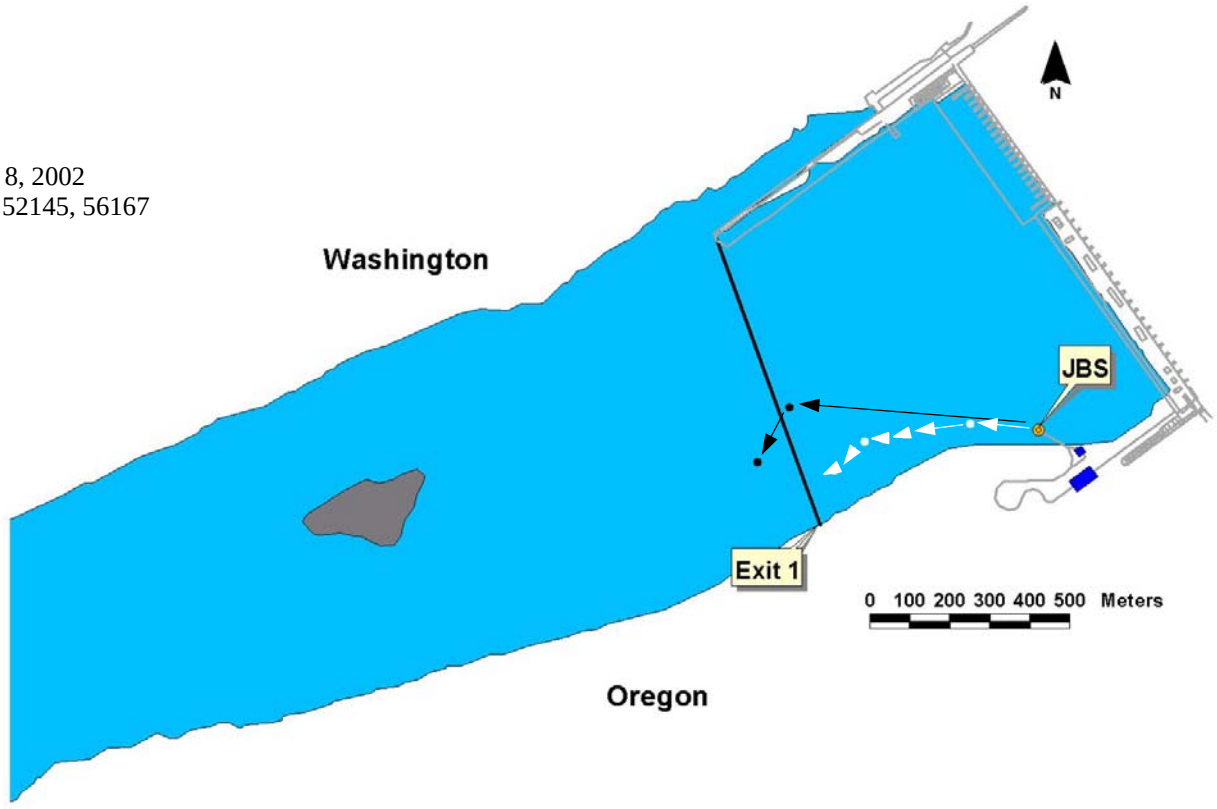


57% Spill; Juvenile Steelhead

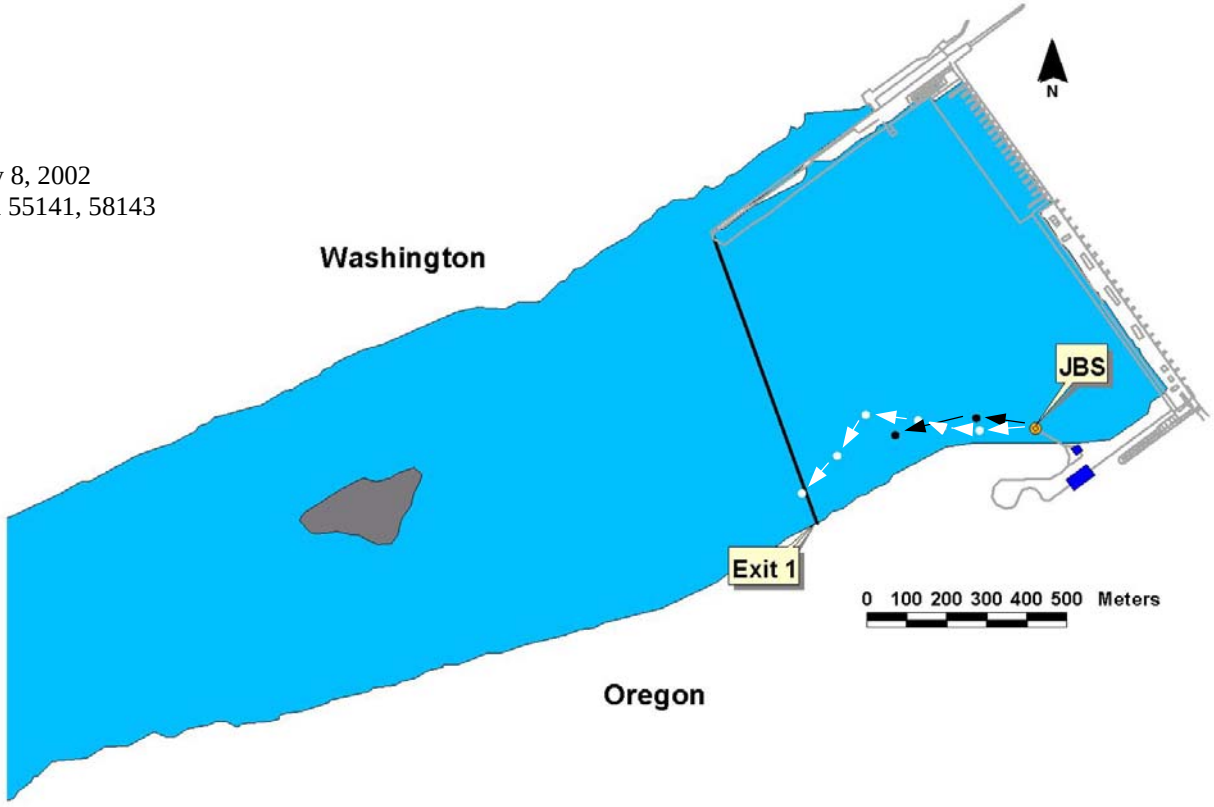
May 6, 2002
Fish 55143, 58141, 56169



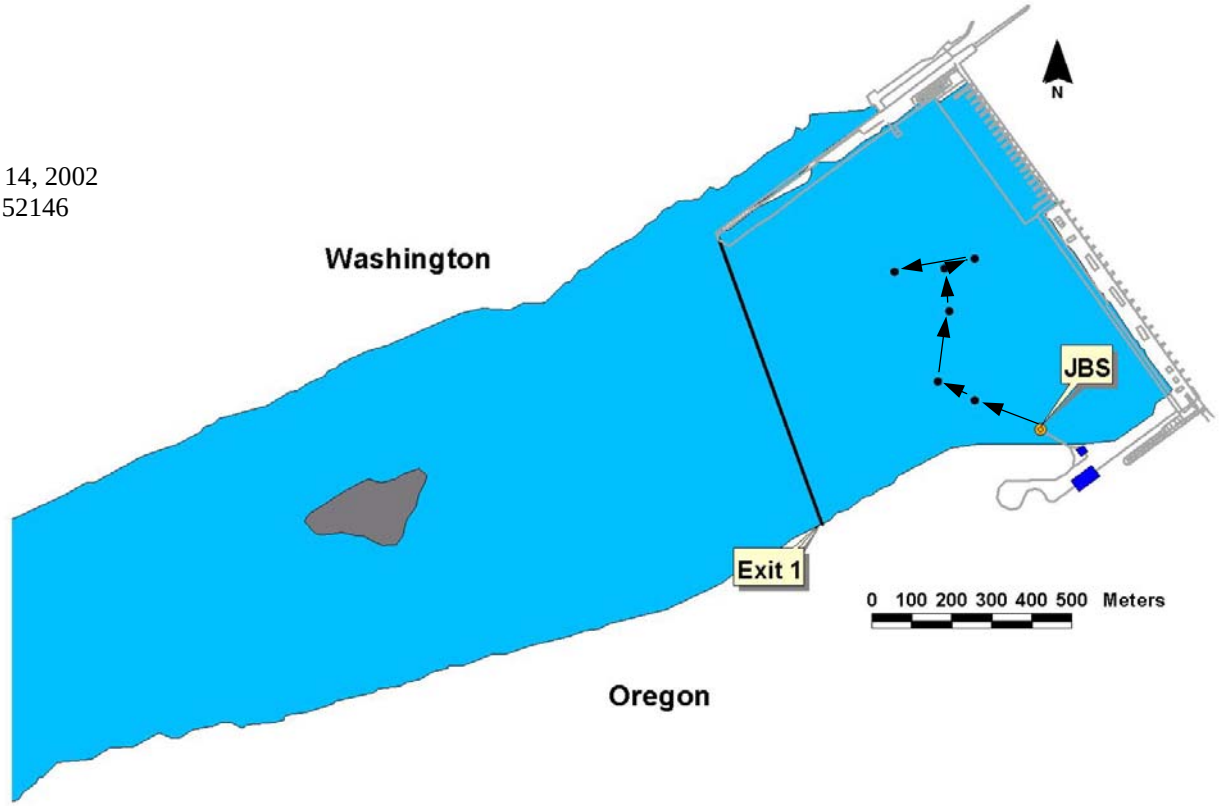
May 8, 2002
Fish 52145, 56167



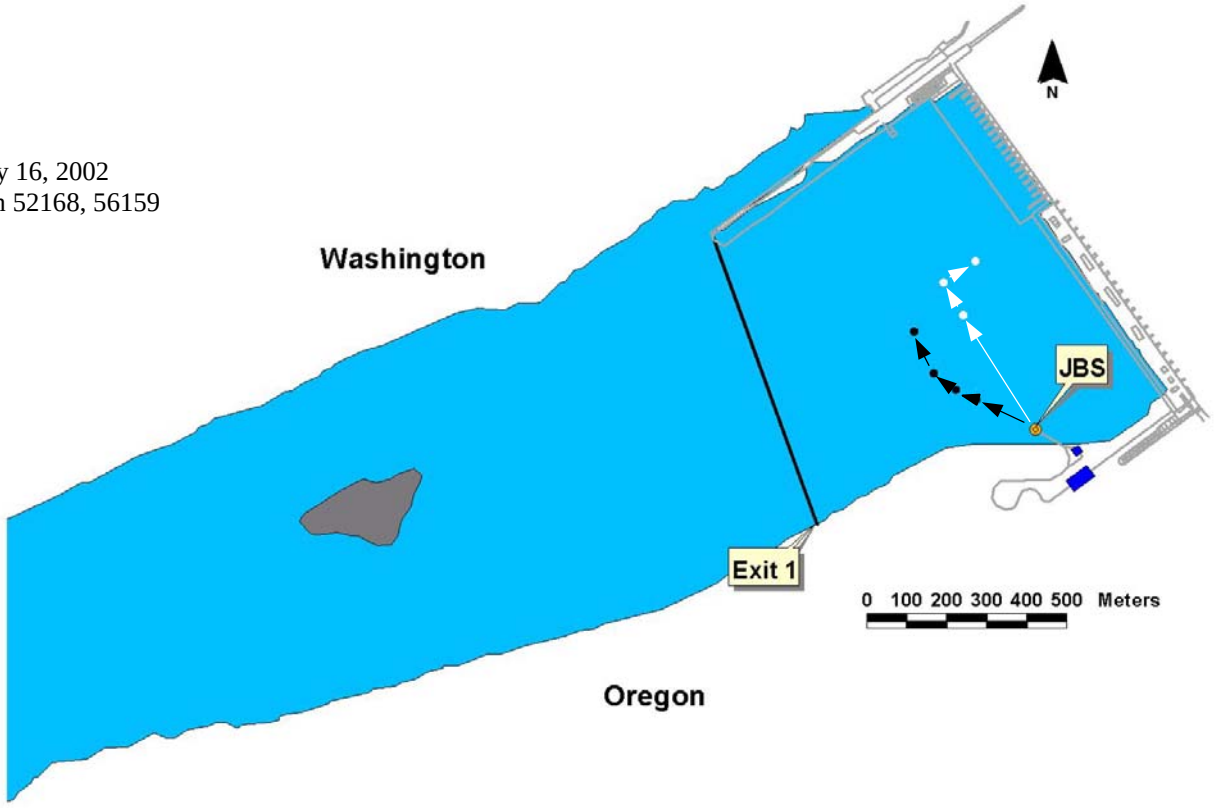
May 8, 2002
Fish 55141, 58143



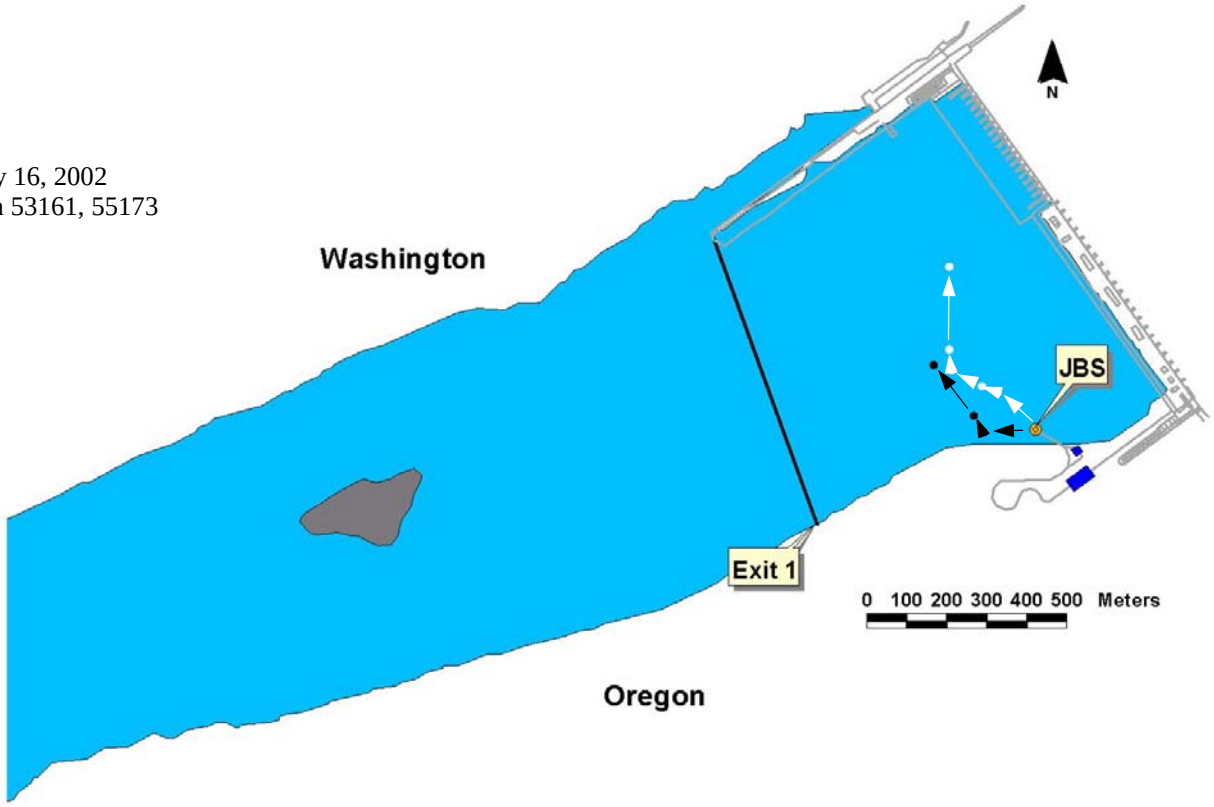
May 14, 2002
Fish 52146



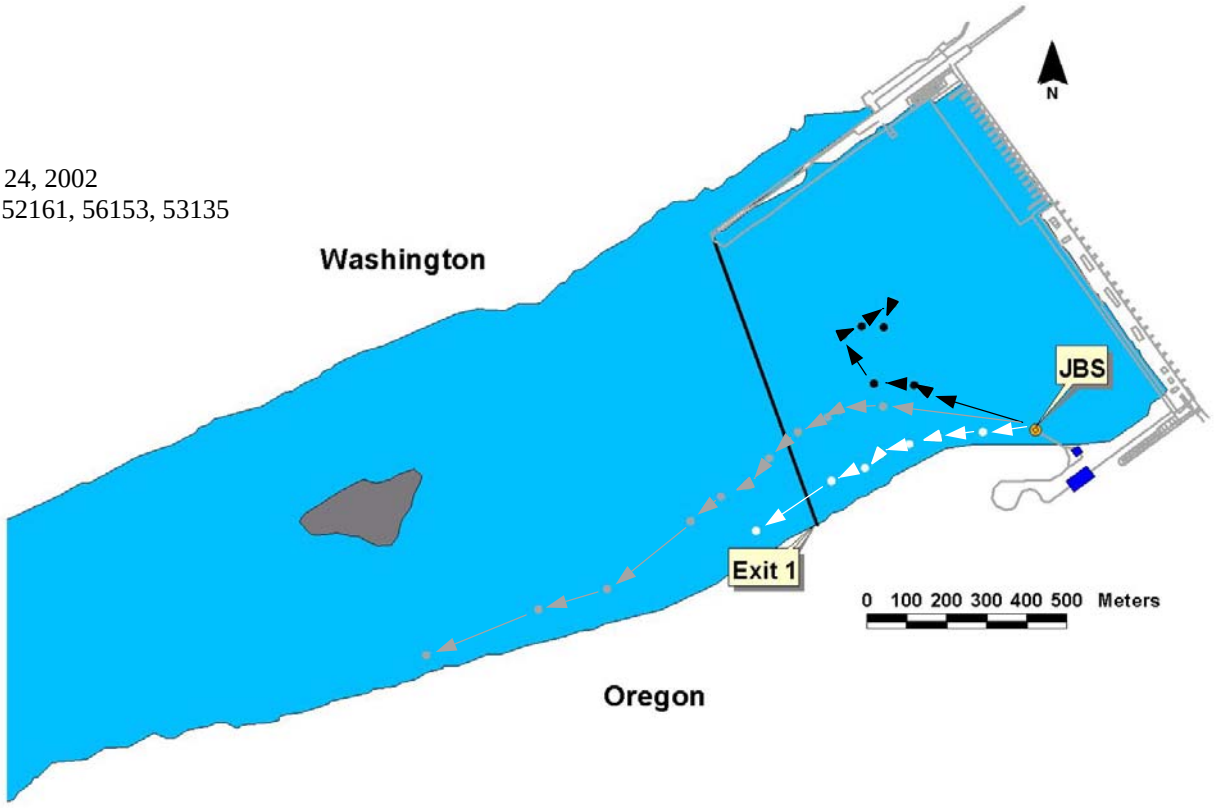
May 16, 2002
Fish 52168, 56159



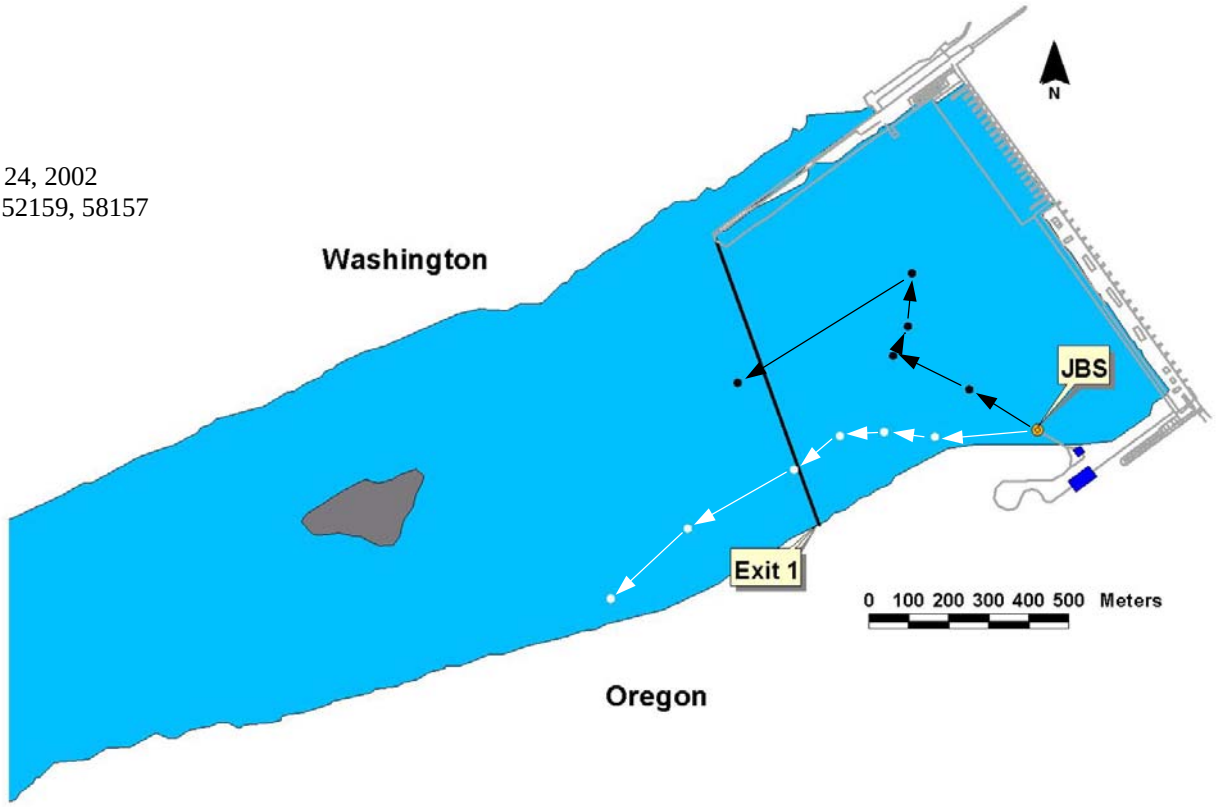
May 16, 2002
Fish 53161, 55173



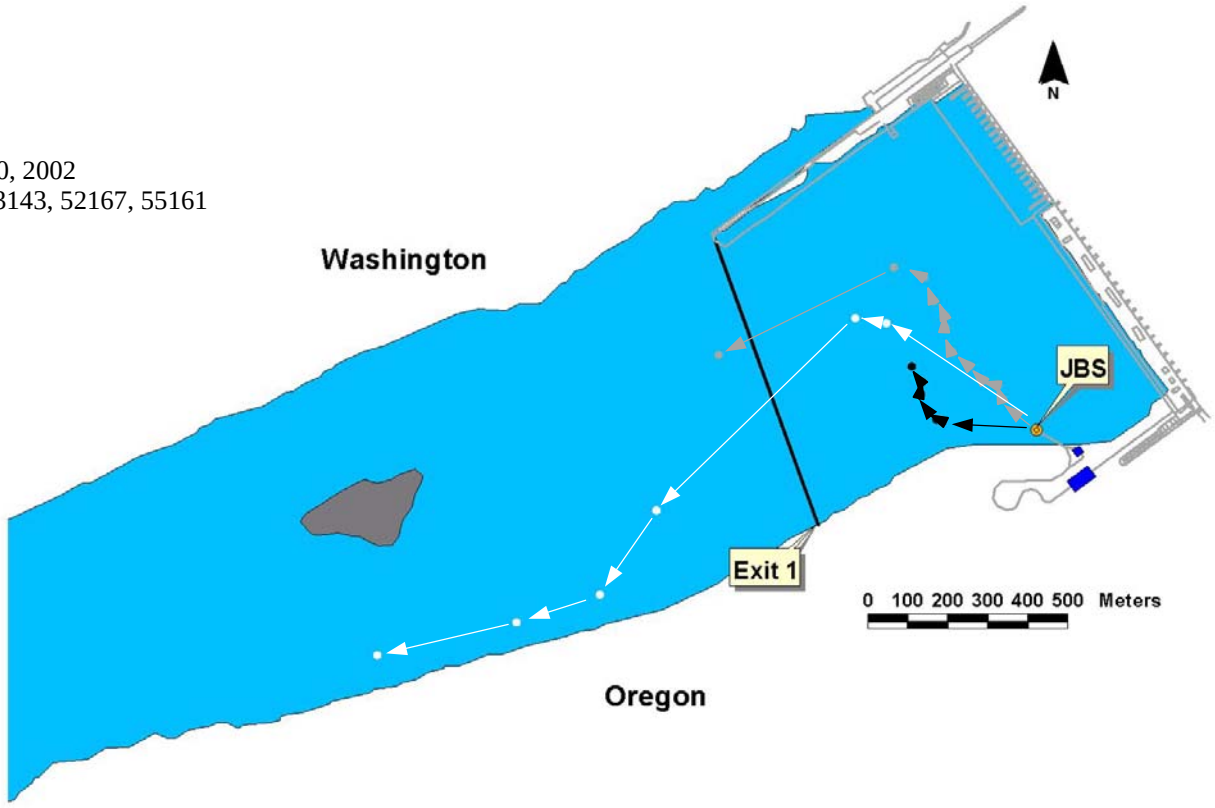
May 24, 2002
Fish 52161, 56153, 53135



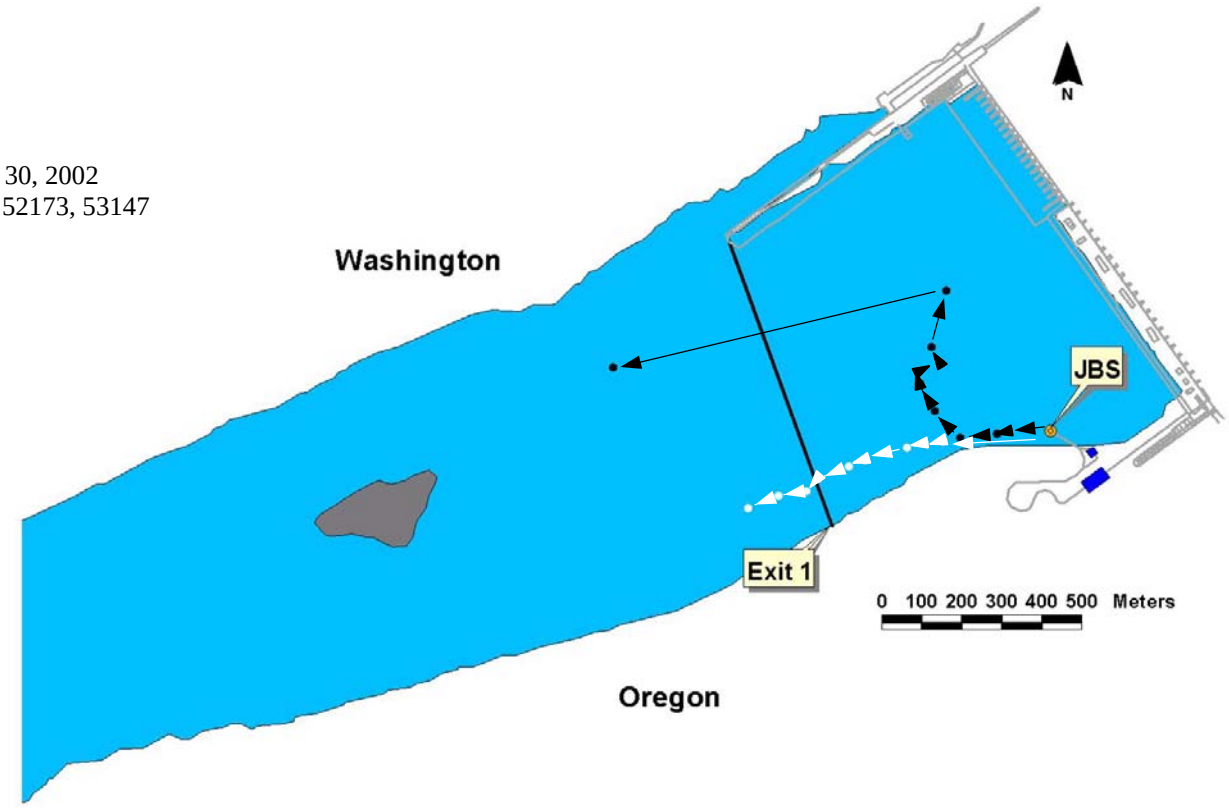
May 24, 2002
Fish 52159, 58157



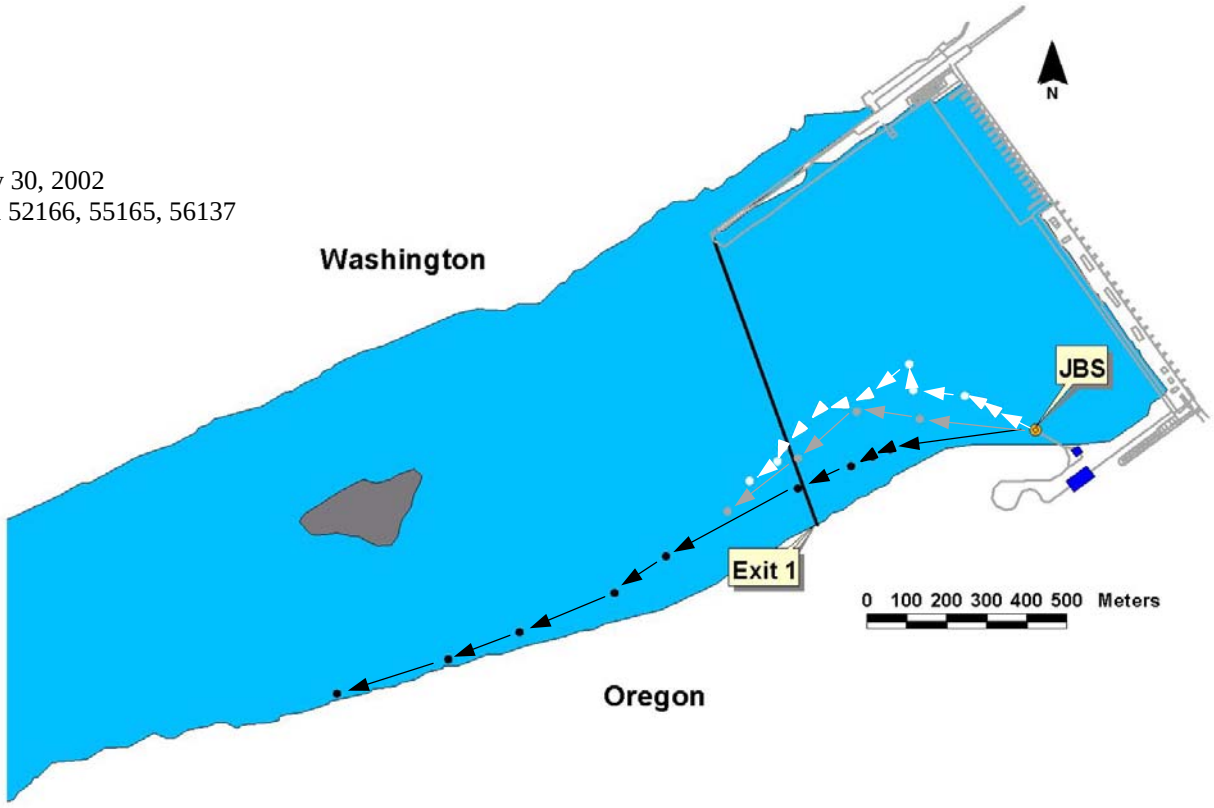
May 30, 2002
Fish 53143, 52167, 55161



May 30, 2002
Fish 52173, 53147

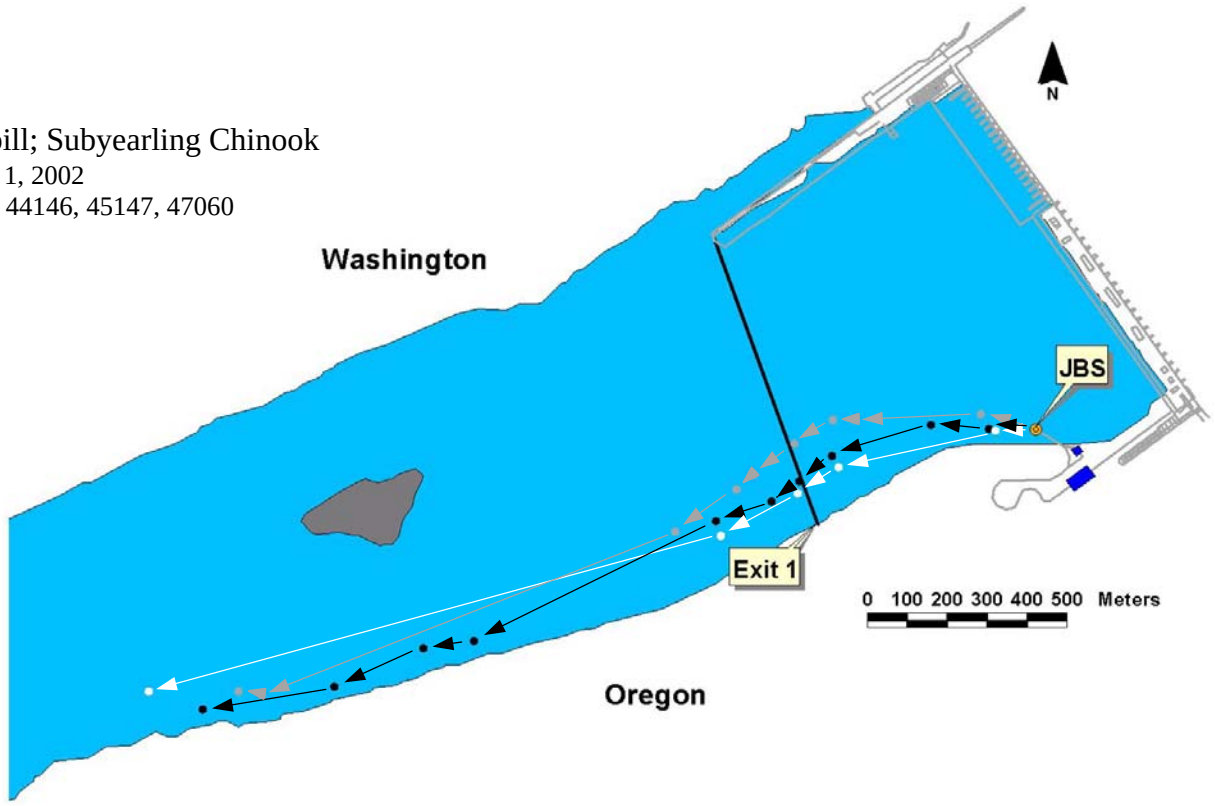


May 30, 2002
Fish 52166, 55165, 56137

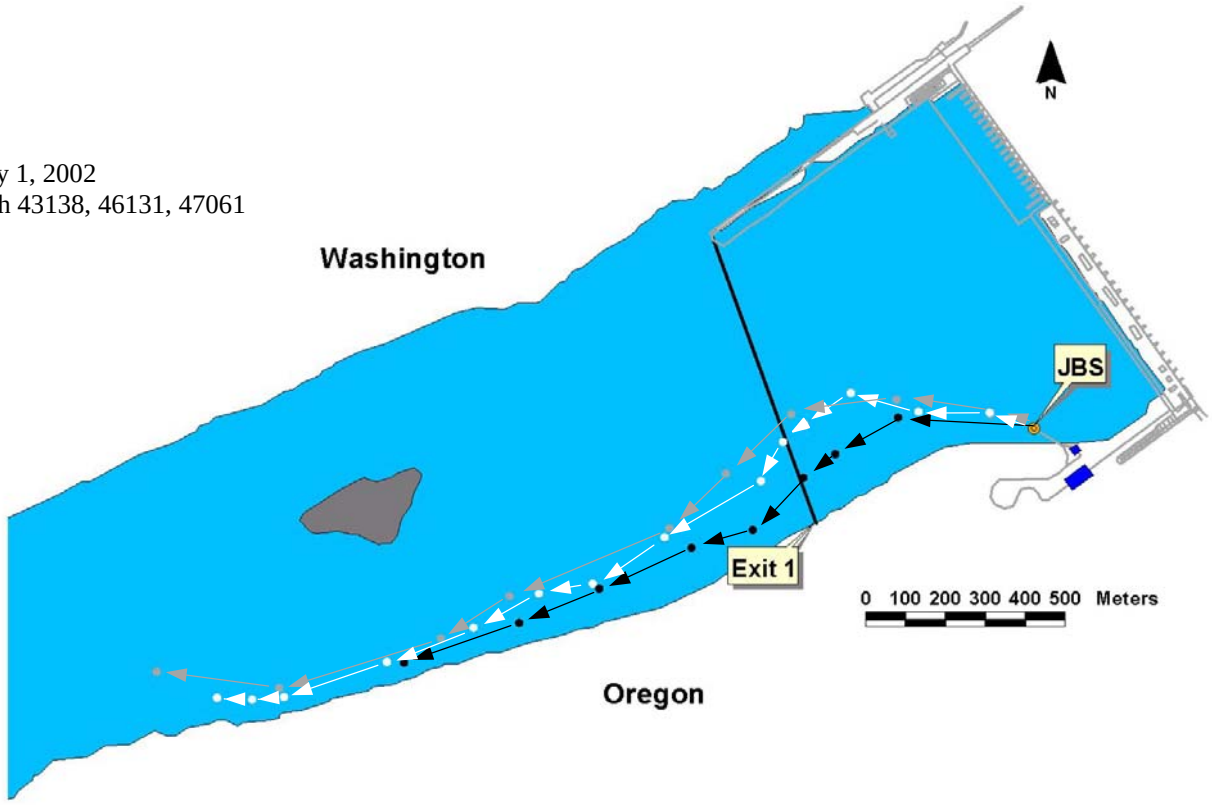


33% Spill; Subyearling Chinook

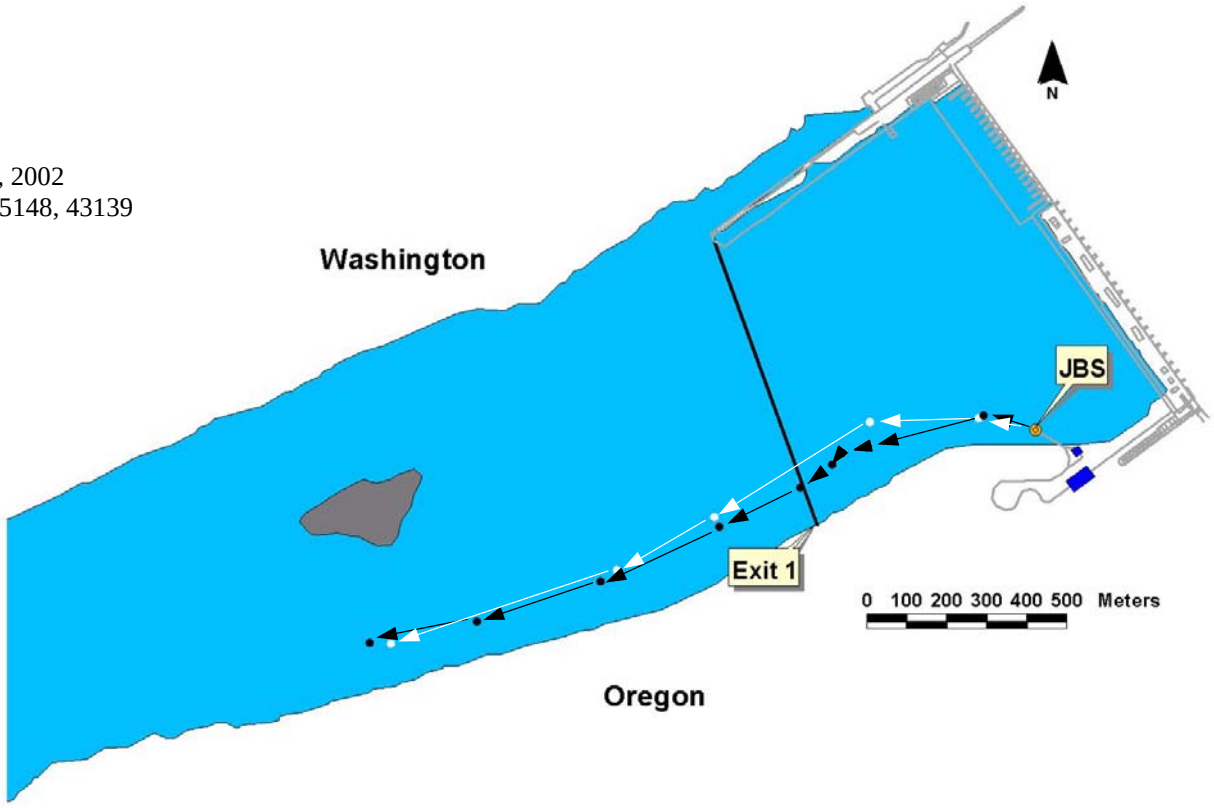
July 1, 2002
Fish 44146, 45147, 47060



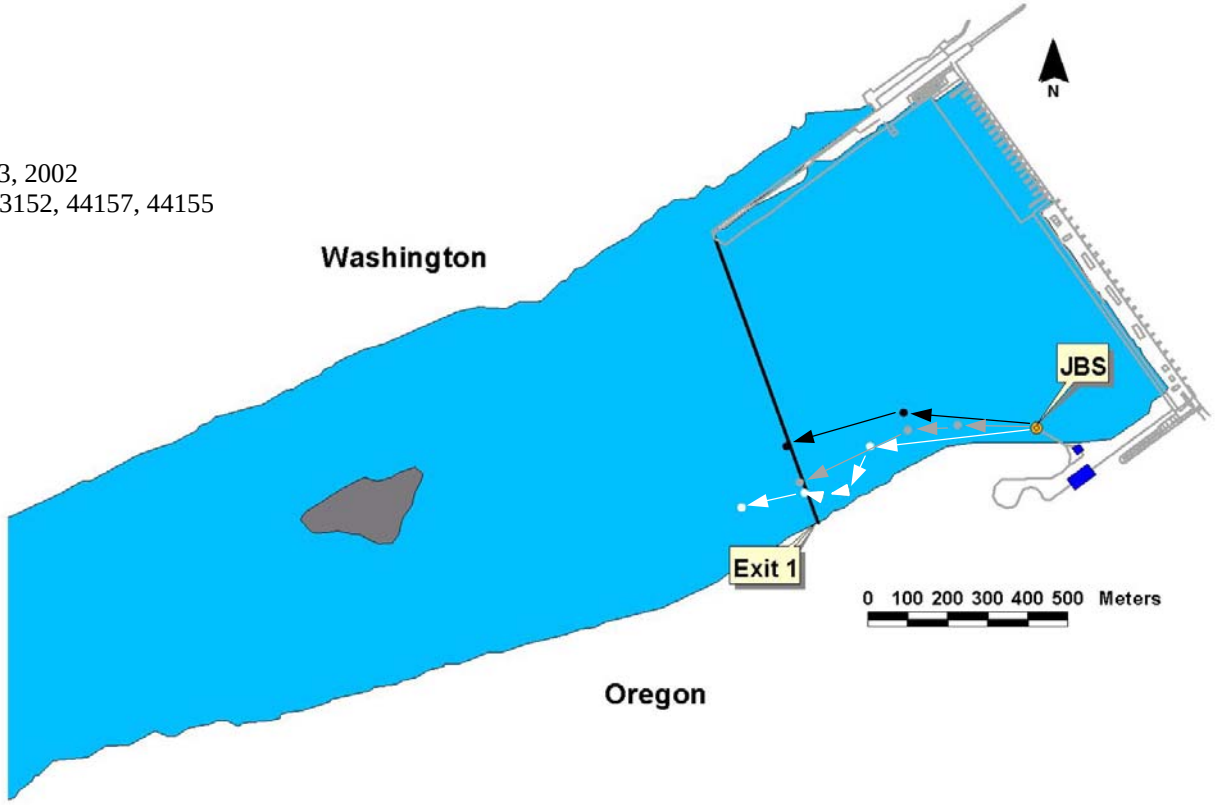
July 1, 2002
Fish 43138, 46131, 47061



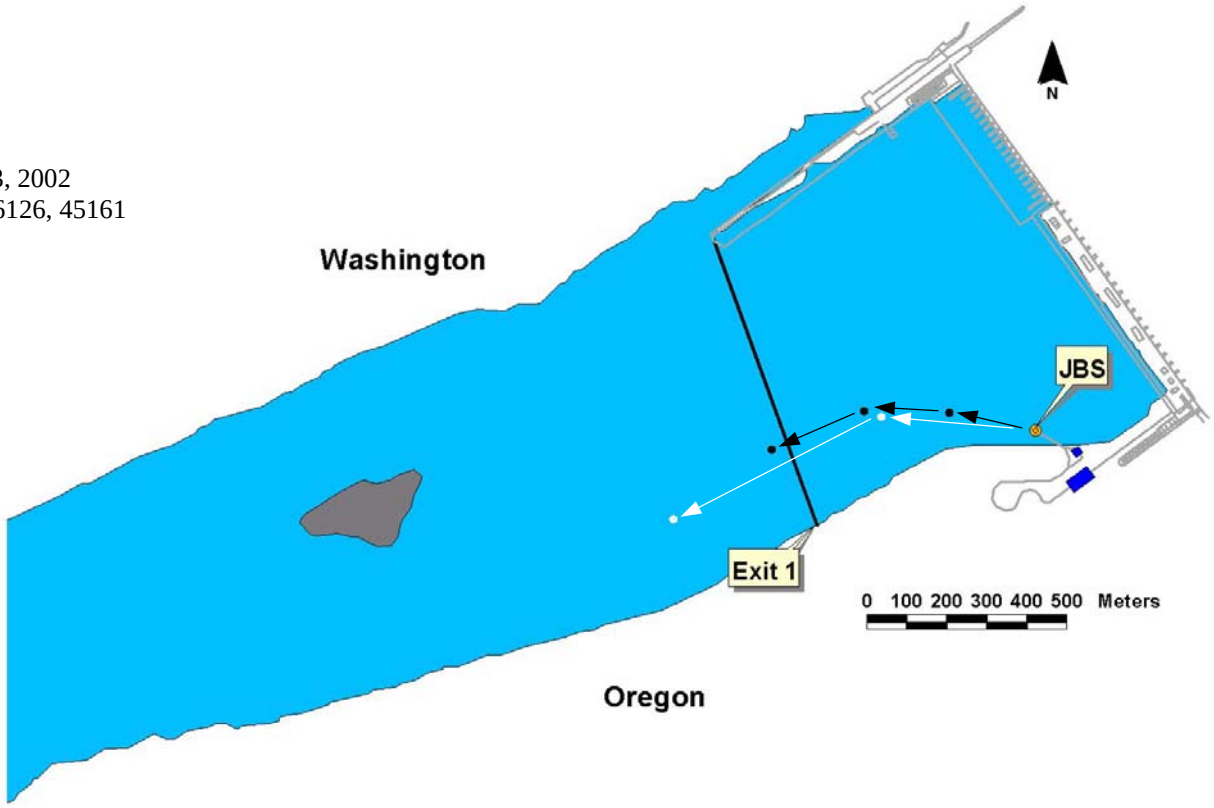
July 1, 2002
Fish 45148, 43139



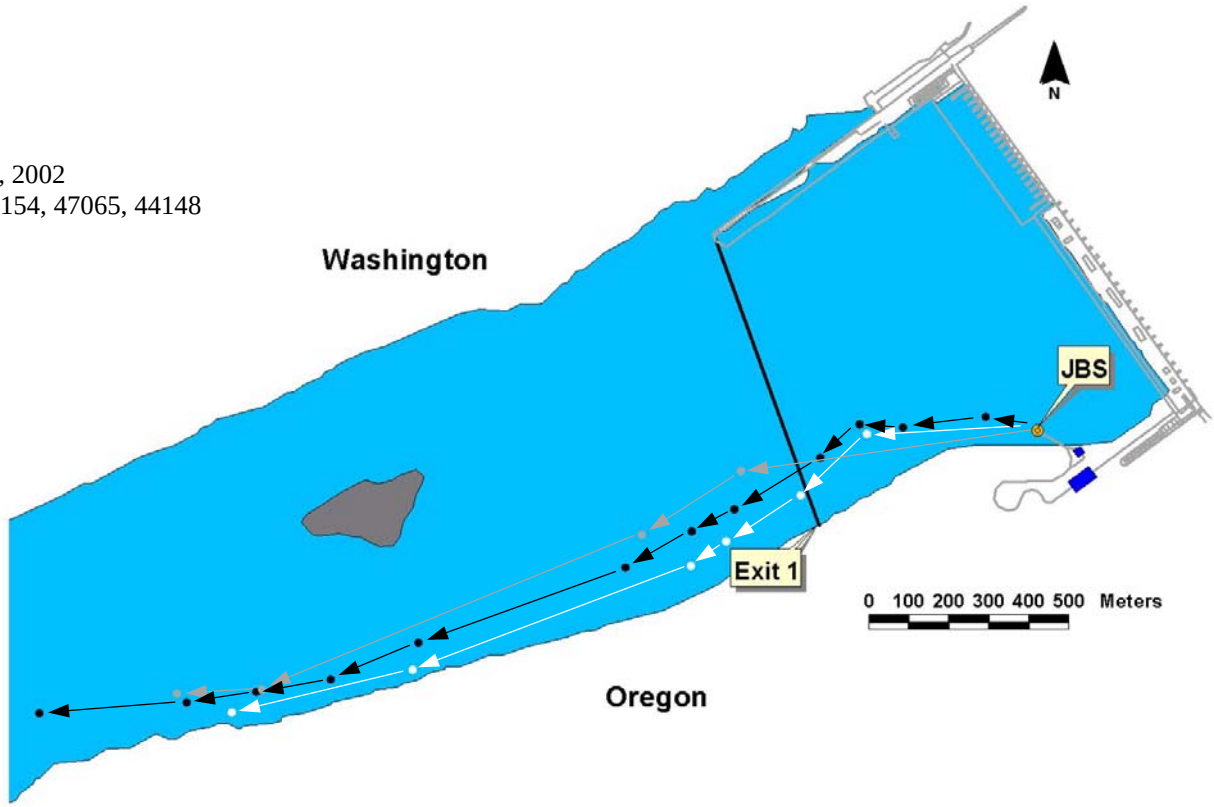
July 13, 2002
Fish 43152, 44157, 44155



July 13, 2002
Fish 46126, 45161

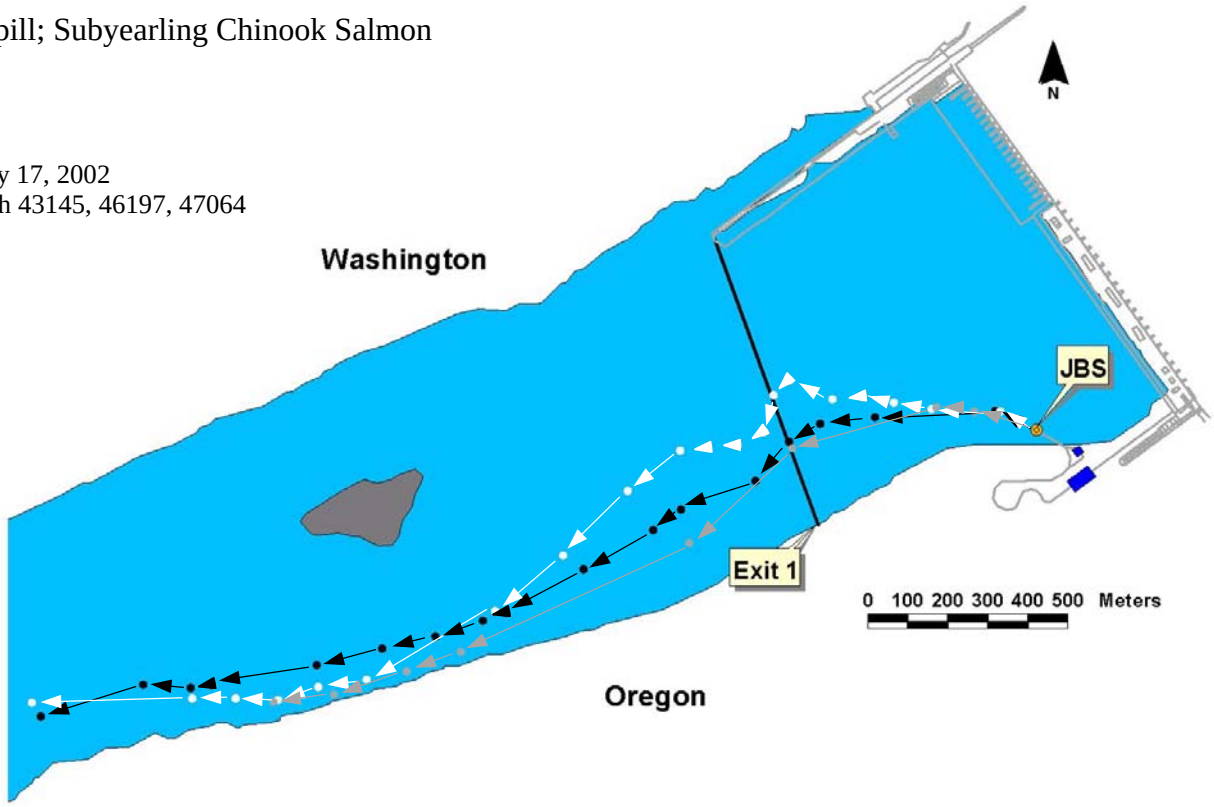


July 17, 2002
Fish 45154, 47065, 44148

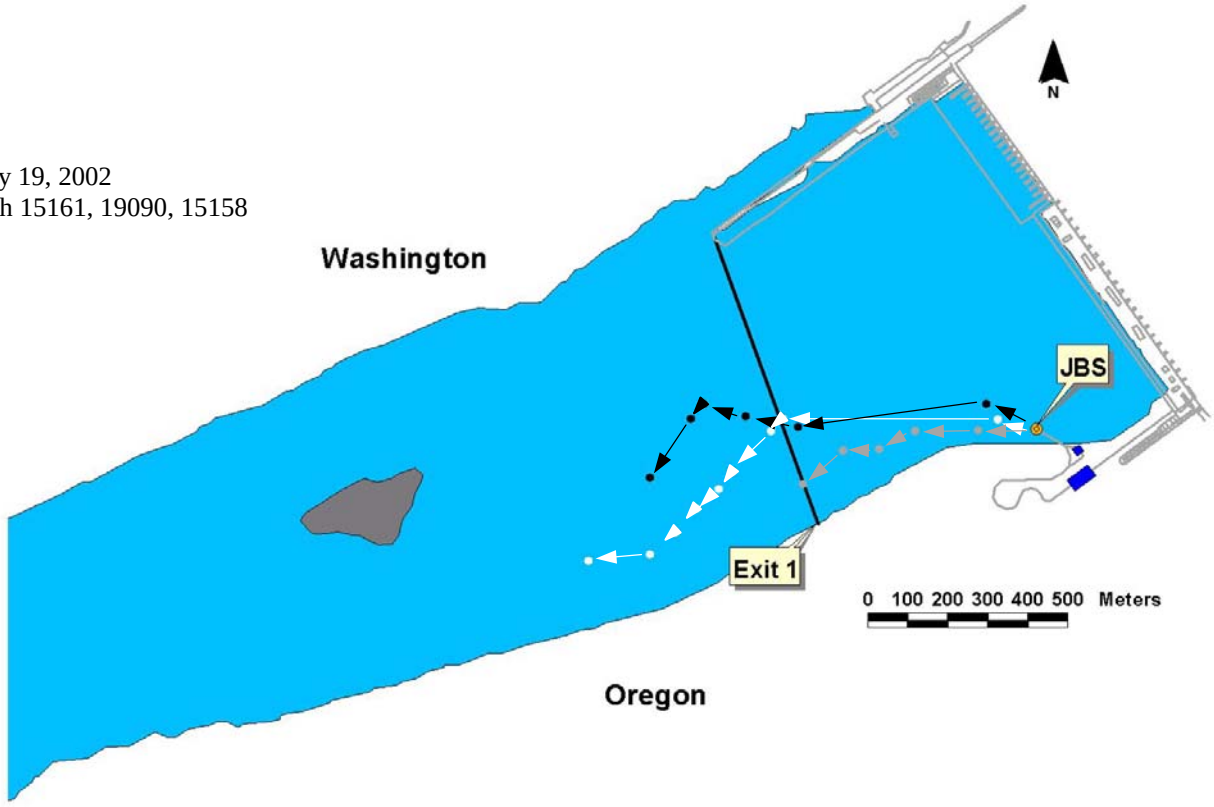


54% Spill; Subyearling Chinook Salmon

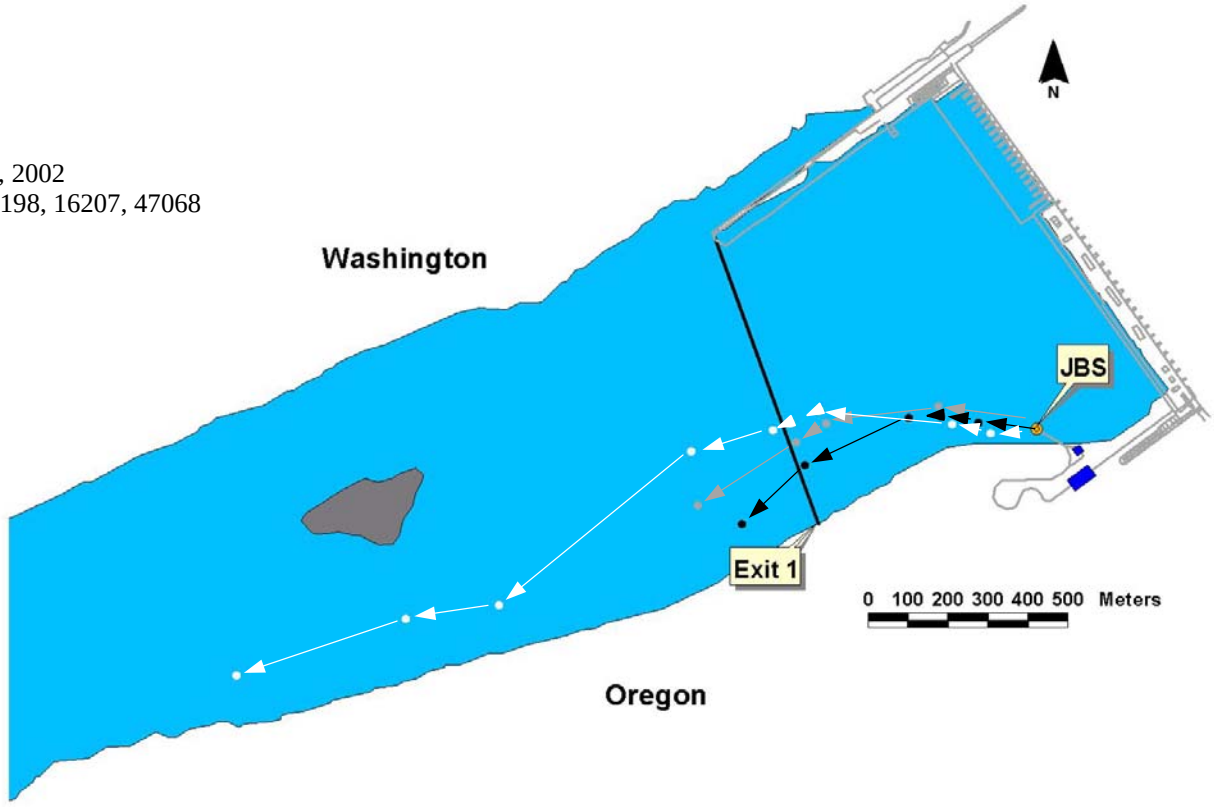
July 17, 2002
Fish 43145, 46197, 47064



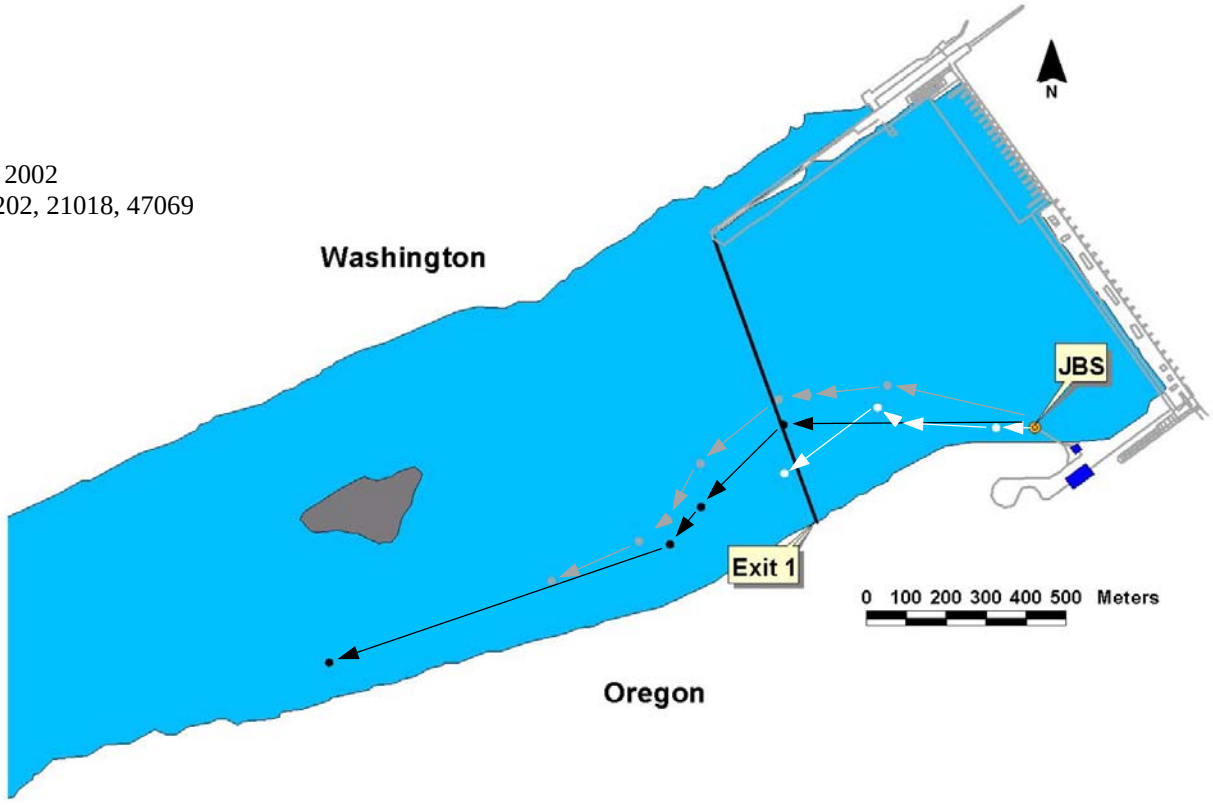
July 19, 2002
Fish 15161, 19090, 15158



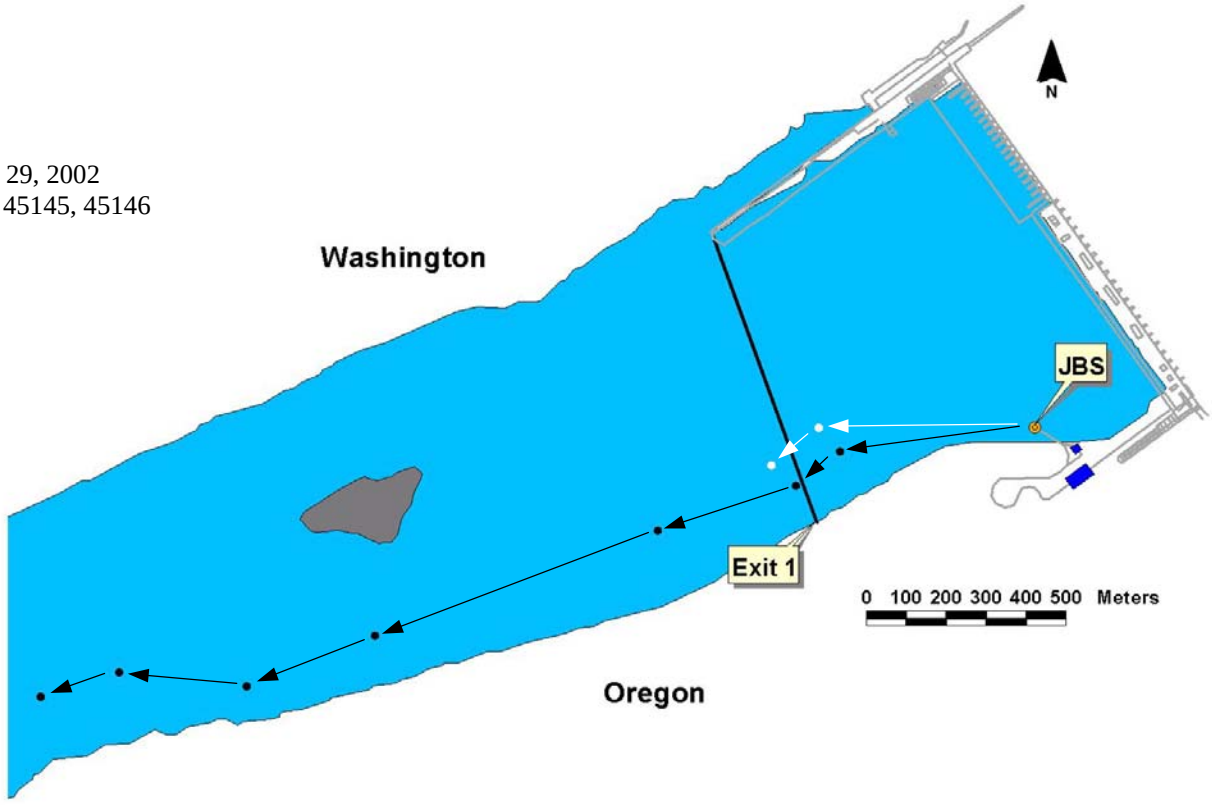
July 19, 2002
Fish 10198, 16207, 47068



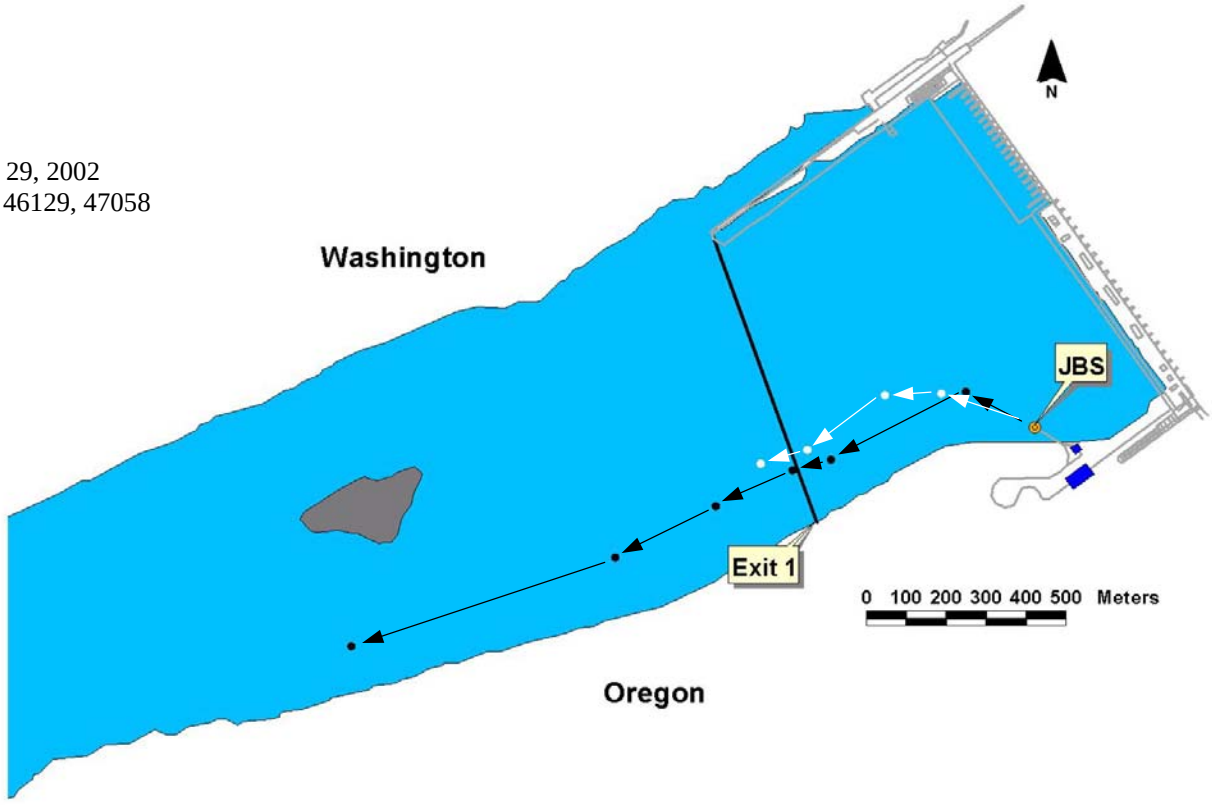
July 19, 2002
Fish 17202, 21018, 47069



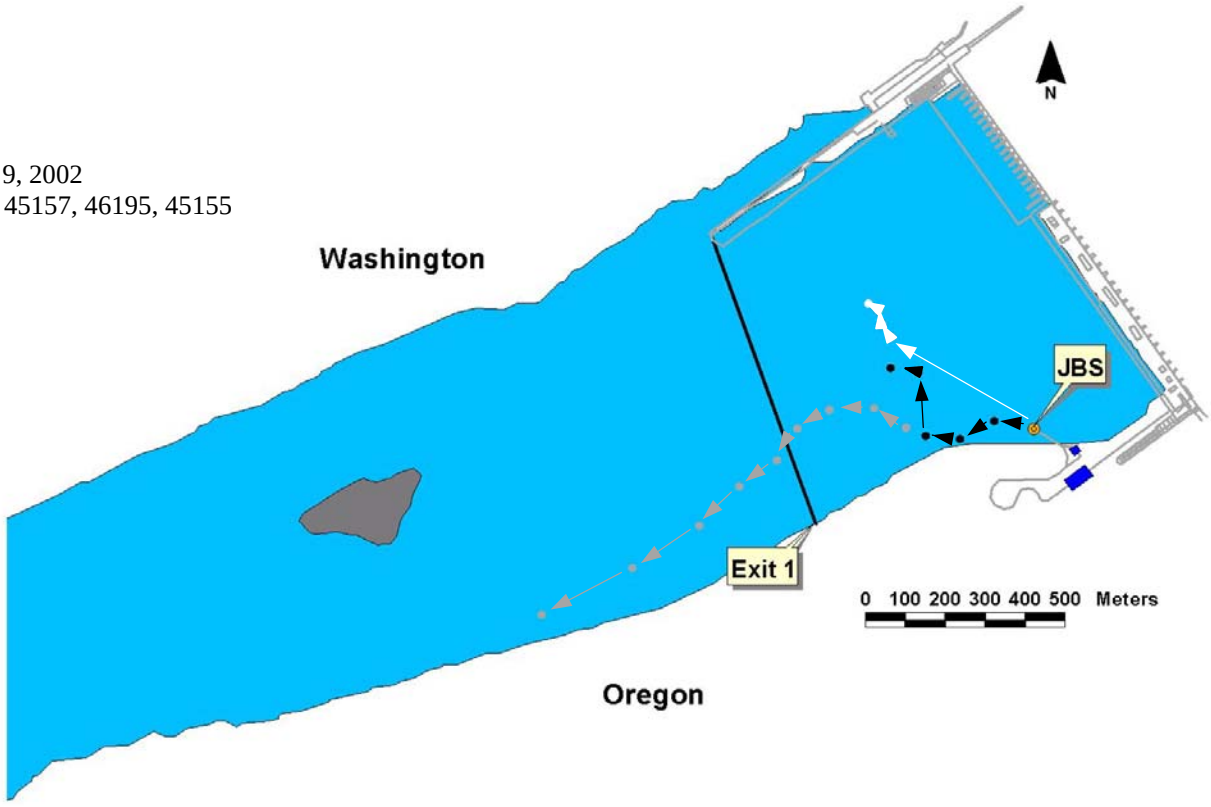
June 29, 2002
Fish 45145, 45146



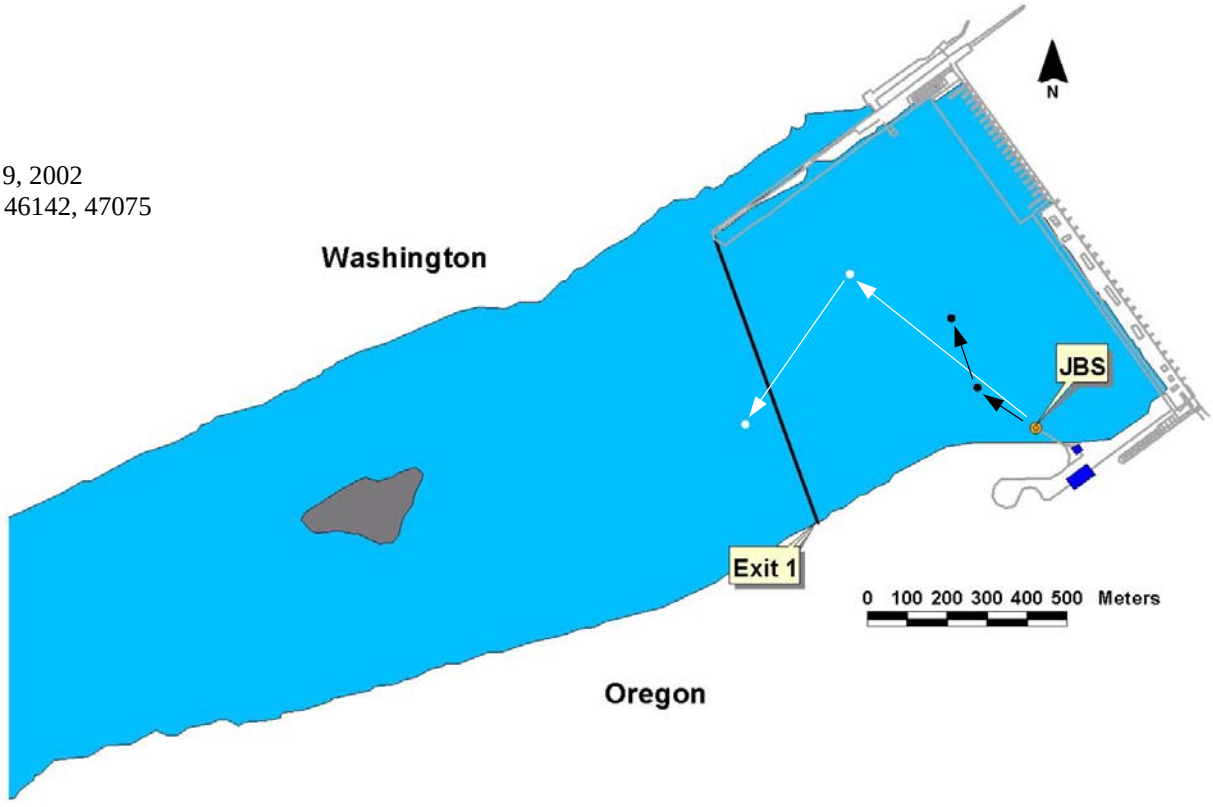
June 29, 2002
Fish 46129, 47058



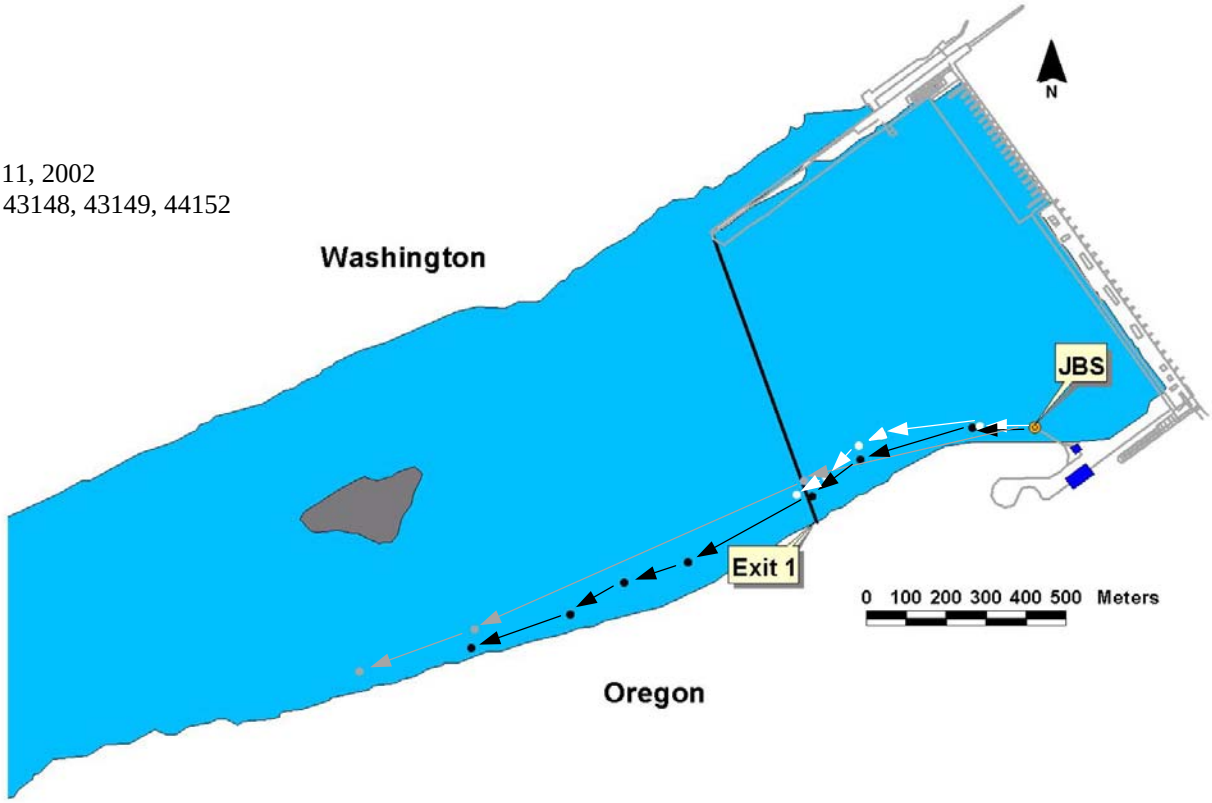
July 9, 2002
Fish 45157, 46195, 45155



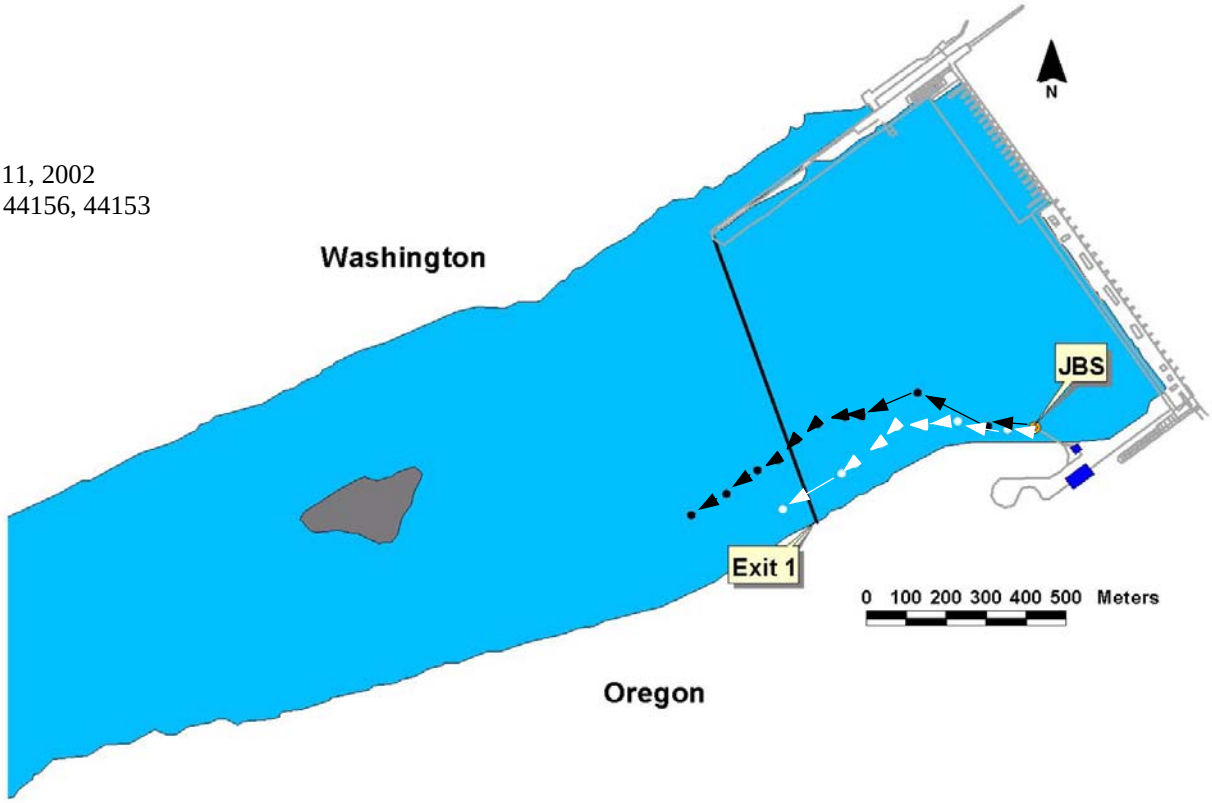
July 9, 2002
Fish 46142, 47075



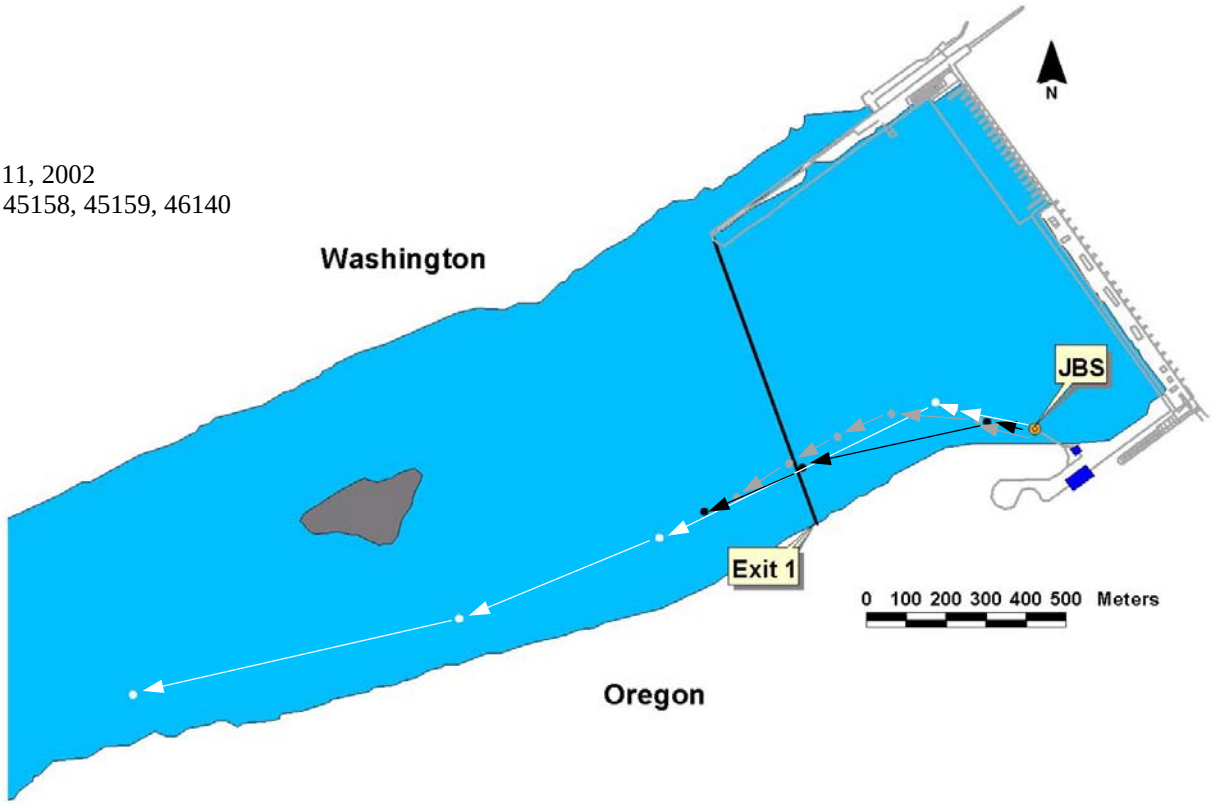
July 11, 2002
Fish 43148, 43149, 44152



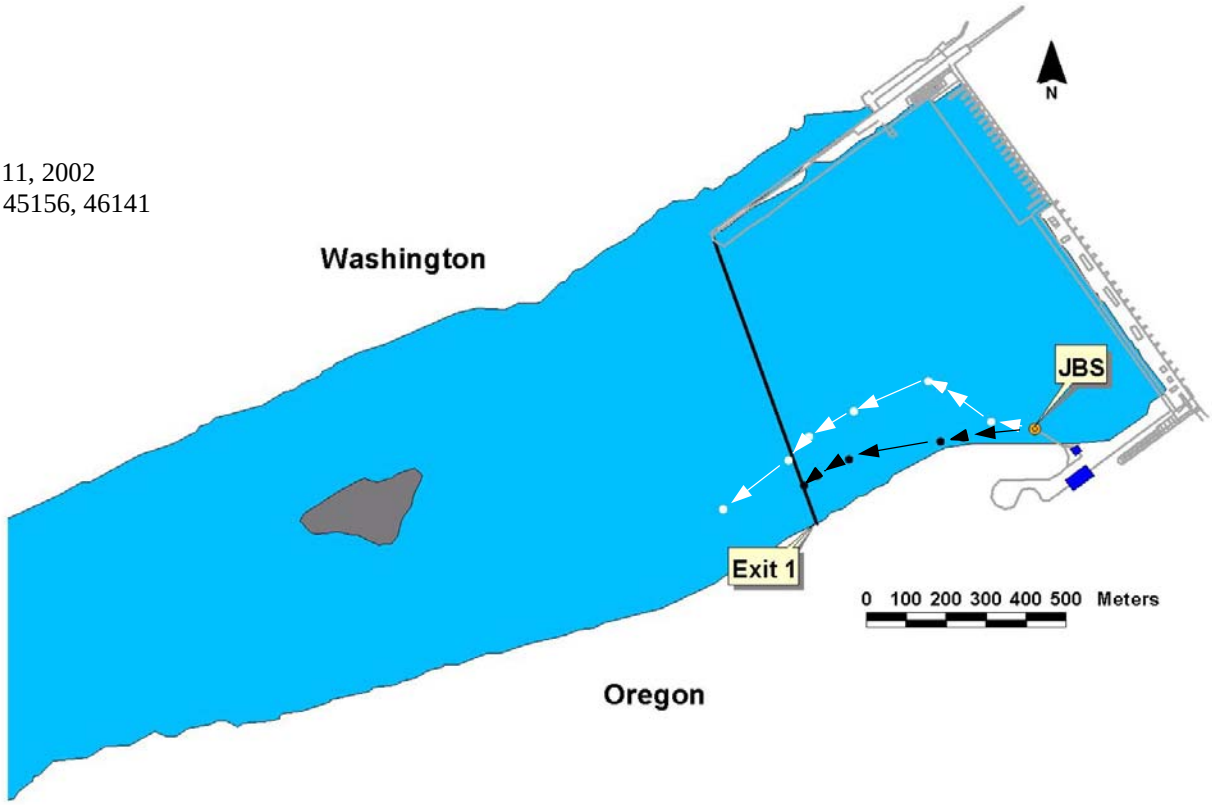
July 11, 2002
Fish 44156, 44153



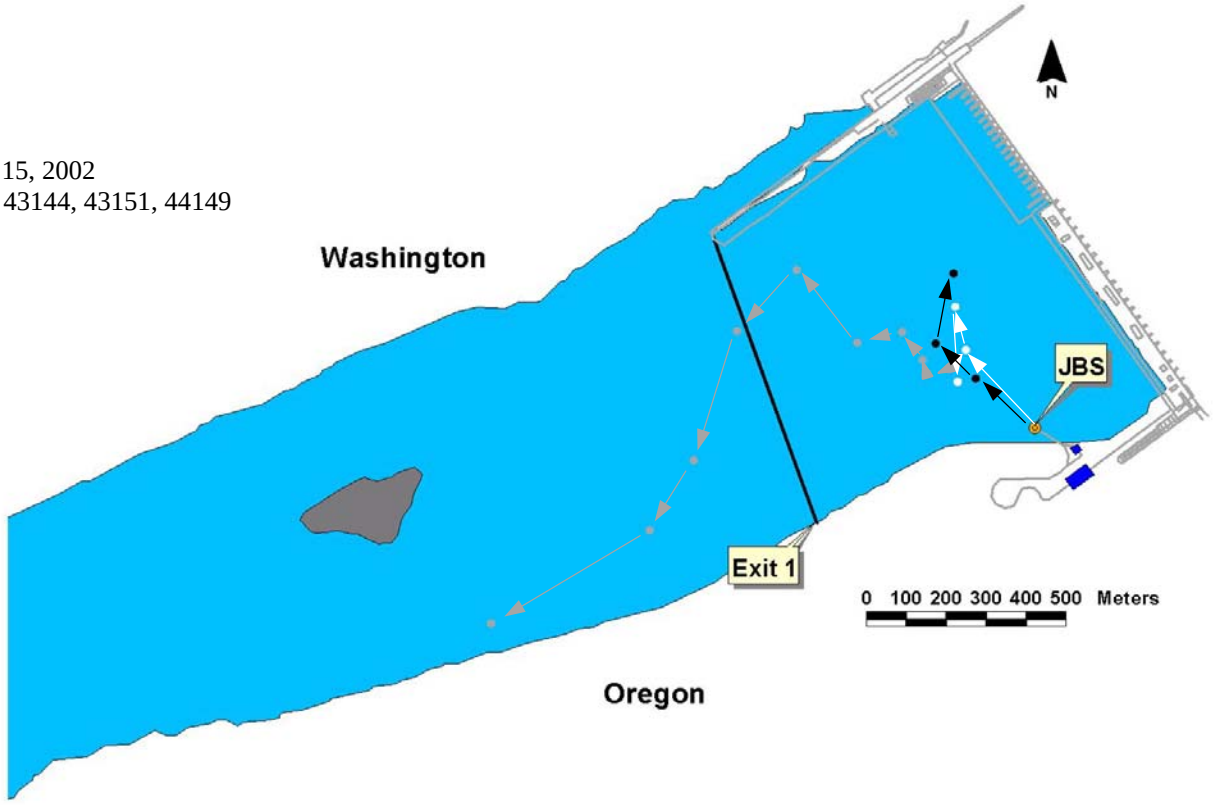
July 11, 2002
Fish 45158, 45159, 46140



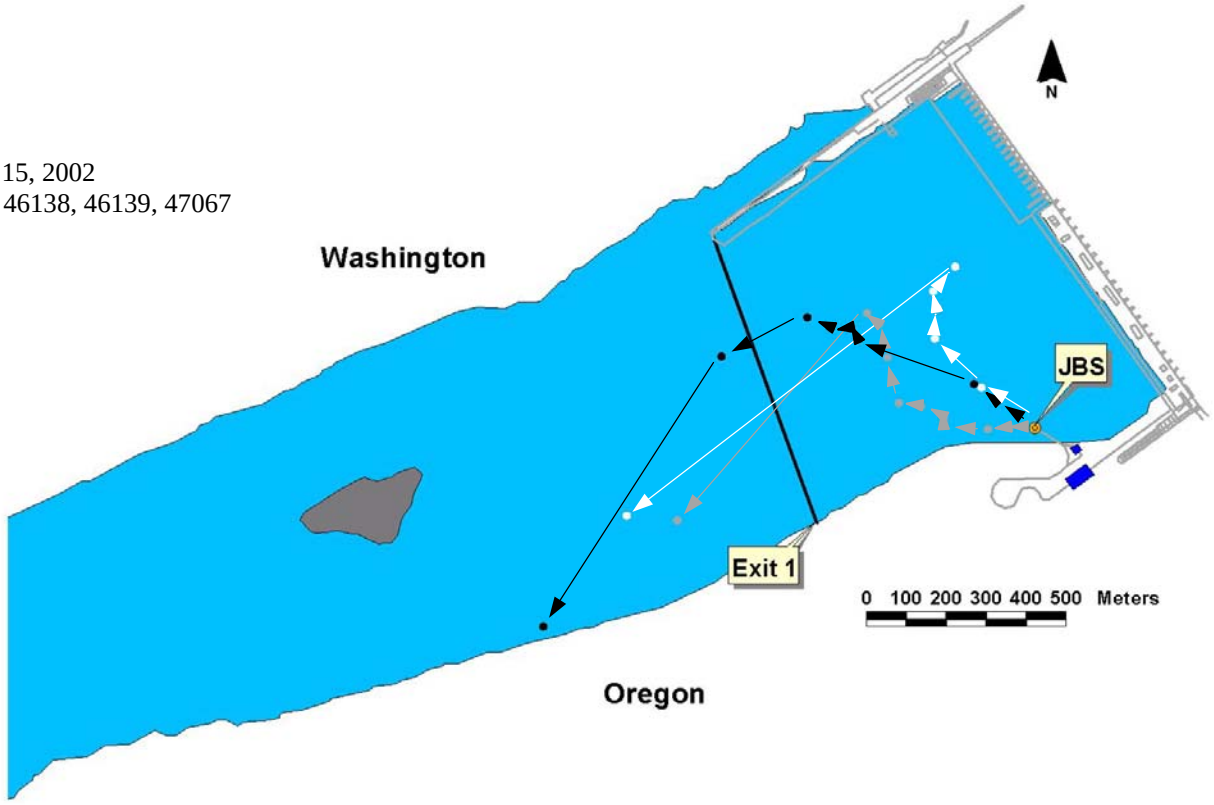
July 11, 2002
Fish 45156, 46141



July 15, 2002
Fish 43144, 43151, 44149



July 15, 2002
Fish 46138, 46139, 47067



July 15, 2002
Fish 47066, 47072, 47073